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ABSTRACT

This curriculum package is designed to be used as a guide for vocational agricultural teachers to use in preparing a third-year curriculum to meet local community or regional needs. The introductory section of the guide is a teacher orientation that covers such topics as the use of these curriculum materials with disadvantaged and handicapped students, guidelines for minimizing sex bias in vocational agricultural classes, suggested planning strategies, the objectives of the course, the validation of the materials, and the content of a four-year agricultural course. Addressed in the individual sections of the course are the following topics: land management and survey, animal science, electricity and electric motors, plumbing, informative speaking, applications, repair welding, tillage and planting equipment, meats, berry production, grass seed production, nursery production, landscape design, Christmas tree production, range management, harvesting equipment, bees, and chainsaws. Each unit contains some or all of the following: a teacher's guide, objectives, an instructional text, a summary, guidelines for presenting the unit, a list of necessary teaching aids, student activities, and a list of references. (MN)

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Teacher Orientaition to Curriculum Package Acknowledgements

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9.	Mike Williams	Gervais High School
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12.	Charles Ramos	Rogue River High School
13.	Bryan Starr	Sutherlin High School
14.	Loren Bebb	Prairie City High School
15.	Jim Murphy	Amity High School
16.	Rob Horn	Oakland High School
17.	Joanne Barta	Harrisburg High School
18.	Bill Jeskey	Cascade High School

Section	Title
a	Teacher Orientation to Curriculum Package
	1. Acknowledgements
	2. Table of Contents
	3. Use of Curriculum Material
	4. Disadvantage and Handicapped Student Use of Materials
	5. Sex-Bias Statement
	6. Planned Course Statement
	7. Advanced Planning Suggestions
	8. Curriculum Validation Statement
	9. Four Year Units Outline
I	Introduction of Ag III to Students
II	Land Management and Survey
III	Animal Science
	A. Animal Reproduction
	B. Livestock and Poultry Diseases
IV	Electricity and Electric Motors
V	Plumbing
VI	Informative Speaking
VII	Records
VIII	Applications
IX	Repair Welding
X	Tillage and Planting Equipment
XI	Meats
XII	Berry Production
XIII	Grass Seed Production
XIV	Nursery Production
XV	Landscape Design
XVI	Christmas Tree Production
XVII	Range Management
XVIII	Harvesting Equipment
XIX	Bees
XX	Chainsaws

Use of Curriculum Material

This curriculum package was developed to be used as a guide which vocational agriculture teachers could use in preparing curriculum which would meet local community/regional needs. The Vocational Agriculture Instructor should use a local Vocational Agriculture Advisory Committee to evaluate the appropriateness of this material to a given locale and eliminate that part of the material which was not appropriate while supplementing with material the advisory committee and instructor deemed appropriate to bring the curriculum package to completion for a specific program.

Remember that the goal of vocational agriculture is to place people in the agricultural occupations of their choice. The instructor should help students set realistic occupational goals in agriculture then, through advisory committee input, designs curriculum which would allow students to meet those goals.

Accountability of vocational programs has been and will continue to be measured by placement of students in occupations appropriate to the subject matter taught. An important criteria for success with regard to a placement standard would be student selection. If you need help with identifying appropriate student selection criteria refer to the "Policies and Procedures Handbook for Oregon Vocational Agriculture Programs by John Oades and Jacquelyn Deeds. Pages 4 & 101 could be particularly useful to the establishment of a student selection policy.

VOCATIONAL AGRICULTURE AND THE SPECIAL NEEDS LEARNER

Every person in our schools, whether educator or student, differs from everyone else and, therefore, has different needs. Taken to an extreme, nearly everyone has *special needs,* such as, less than 20/20 vision, insufficient upper-body strength, inability to read at a desired level or speed. Most people can overcome or *compensate* for their *special needs.* Insufficient visual acuity can often be corrected by eyeglasses, inadequate strength through the use of other parts of the body as well as technology, low reading skills can be improved if desired and opportunities to learn are available. However, not all persons can *compensate* for their *special needs* without help. These are the persons this section addresses.

1. *Who are special needs learners?*

In the simplest terms, special needs learners are the students who are failing in your vocational program and will continue to do so unless special help is provided. They are also students in your school who have not yet enrolled in your program but who would probably fail if they did without special assistance. In summary, two points are important: (1) they will fail or continue to fail (2) without special help.*

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* There is actually a third criterion. These students are not succeeding or cannot be expected to succeed due to one of the following reasons:

1. A handicap or disability (the student will have or ought to have an individual education plan or IEP).
2. Academic disadvantagement (the student has not adequately learned to read, write, compute or speak but are not disabled or handicapped).
3. Economic disadvantagement (the student has not learned or does not display appropriate work attitudes for employment in agricultural or agribusiness occupation or to succeed in your program).
4. Limited-English proficiency (the student does not speak, understand or write English well enough for employment in agriculture or agribusiness).

These characterizations are important when designing instructional strategies and for no other reason.

2. *How can you help a special needs learner?*

You can provide a critical facet of a special needs learner's life—*EMPLOYABILITY.* Employability means independence and therefore dignity for the special needs learner. However, helping a special needs learner to acquire occupational competence will require the best teaching possible. Effective teaching will require:

* Knowing the special needs student.
* Knowing this curriculum guide thoroughly.
* Knowing which resources are or should be available to you.
* Being a highly creative problem solver.
* Wanting to work with a special needs learner (without this one, all of the above are immaterial).

3. *Where do you begin?*

"PLANNING." You know that good planning is the foundation of effective instruction. This is doubly true for the instruction of special needs learners. Handicapped or disabled learners will or should have individual education programs (IEP). If a handicapped learner will be mainstreamed into your program, you *must* participate in the development of the IEP. You as the occupational expert are a critical member on the IEP team.

The IEP team should also develop an individual vocational education program (IVEP) for each handicapped learner. The IVEP should describe in detail: (1) the competencies that the student should learn, (2) where the student will learn each competency (e.g., class, SOEP), (3) criteria for determining success, and (4) the resources, including aides or peer tutors, materials, resource teacher, etc., that will be needed to accomplish each teaching-learning task. Although IEP's are not required for disadvantaged and limited-English proficiency learners, it may be helpful to form IVEP teams with remedial reading teachers, language or bilingual education teachers, counselors or whomever is appropriate.

4. *What information is needed?*

You can learn about the special needs student in the IEP/IVEP meeting. You need the information to participate productively in discussions and to plan your instruction later. Questions for which you will need answers are:

* What can the student *now* do?

* What does the student like to do? In particular, what are the person's occupational interests.

* How does the student learn best?

* What are realistic occupational goals for the student at this time? (Occupational goals can be modified upwards at a later time.)

You can help the IEP and IVEP team by providing information on:

* Occupations and employment trends in agriculture and agribusiness.

* Competencies, including basic academic skills, necessary to become employable in specific occupations.

* Competencies that can be learned in Ag III which relate to those occupations.

* Resources and support services that you would need so that the student can learn specific occupations.

* Potential SOEP or cooperative work experience sites.

5. *How do you teach a special needs student?*

Based on an IVEP you should already know:

* The occupation or groups of occupations the student is preparing for.

- **The competencies that the student should learn in Ag III.**
- **The student's abilities, interests and preferred learning modes.**

Knowing these things, teaching now becomes a matter of *creative problem solving*. Described below are a few simple steps to develop instruction and examples that apply those steps. In the examples, the occupation for which the special needs student is preparing is *greenhouse grower*. The competency which will be used in the examples is: "Prepare rooting media" (this competency would have been listed in the student's IVEP).

(1) ***Identify the learning steps that the student should complete to attain each competency.***

For our example special needs student, you feel that four learning steps should be specified: (1) screen media, (2) sterilize mixed media, (3) fill pots and flats, (4) apply fertilizer to media. The specification of these four instructional steps are based on the student's abilities. Each of these learning steps can be broken down further into smaller steps; the extent to which you need to break down competencies and learning steps depends on the student's abilities. The less able the student, the more you ought to break down competencies into learning steps.

(2) ***Identify the appropriate unit(s) in this guide for each competency and/or learning step.***

The *Horticulture* unit seems to fit the bill for our example student.

(3) ***Analyze the teaching aides, student activities, instructional materials (including overhead transparency masters), and unit tests suggested in this guide which relate to the competencies and learning steps.***

Reading materials on preparing rooting media appear in the nursery production unit in the guide. The information has reading difficulty indux of grade 11.4 using the FOG method. If scientific and technical words are discounted, the readability index falls to grade 9.8. Other things taht students could do are highly activity oriented, that is, hands on. Unit tests are not provided; therefore you will use performance tests to determine whether or not the student can prepare rooting media.

(4) *Use the suggested activities, materials and tests OR modify them so that they are appropriate for the student OR select other more appropriate methods, materials and testing procedures based on the student's abilities and how s/he learns best.*

Suppose our example student is deaf or hearing impaired but is able to read the materials. The suggested activities and materials would be appropriate. During demonstrations, however, you may need to use an interpreter if appropriate. Regardless, make sure that the student can see you clearly. Also, make sure you are not talking and showing at the same time; the student may not be able to "listen" and watch you and the interpreter at the same time. You may wish to discuss with the student the best ways to communicate when you first meet as well as periodically thereafter.

Now as another example, the student is mentally retarded with a third-grade reading level. You also know that this student will work under relatively close supervision on the job and can receive oral instructions. The person also has difficulty assimilating concepts and learns best through actual practice with many repititions of a task. The suggested reading materials may be inappropriate for this student. You may wish to include the student with other students when you demonstrate the preparation of rooting media; however, individualized instruction will more than likely be needed. Instructional aides, peer tutors and "buddies" could be very useful for the individualized instruction.

As a final example, the student is "normal" but has not learned to read adequately. The student can read at approximately the sixth grade level, but the suggested material in this guide are written at the 9.8 grade level. Knowing the student's occupational goals, even if tentative, is critical. If the group of occupations for which the student is preparing requires a reading ability of grade six, then alternative means should be provided so that the student can learn the information in the suggested materials without reading them. If, on the other hand, the occupations require grade 9.8 or higher reading ability, then the student should learn to read at that level. The suggested materials in the unit could be used as a medium through which the student can improve reading competence. You can help the student.*

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* *A Methodology for Reading Skill Improvement in Vocational Secondary Programs* has many hints on how you can help special needs students to learn to read. Copies of this document is available from your regional vocational education coordinator and the Division of Vocational Education, Oregon Department of Education.

(5) *Assure that the student has acquired each competency.*

The students in our examples, regardless of handicap or disadvantagement, need to perform every competency specified in the IVEP to the level of quality required by employers. Incompetence in the student should neither be tolerated by you nor expected by the employer. However, testing should be fair; expect what an employer should expect -- performance under realistic conditions. For our example, close supervision will be provided to the mentally retarded student on the job; realistic supervision should also be provided during the testing. You may also need to retest periodically to assure that the student maintains competencies.

6. *How do you use aides, peer tutors, and resource teachers?*

It usually requires more personnel time in one form or another for special needs students to acquire necessary competencies than it does for other students. Specifying who can best provide the additional time should have been accomplished during the development of the IEP and/or the IVEP.

Special needs students should work with a resource room or remedial reading teacher or other persons in your school *with your close cooperation.* Effective interaction with other teachers, counselors and specialists in your school may need to be developed. A sense of mutual trust and respect between you and other persons working with the student, such as the resource room teacher or the remedial reading teacher, is a necessity. You can help them when they work with special needs students on occupational competencies, including the basic academic skills needed to function on the job. They can serve as a wealth of information and ideas to you on appropriate teaching methods and techniques for a special needs learner. Are you willing to take the first step towards developing effective relationships?

Special needs students should work with aides and peer tutors in your classroom on labs *under your supervision.* Aides and peer tutors should be prepared to work with special needs students. They should be informed of the occupational goal for the student. Then, for each competency, you should inform them of the learning steps and show them how to teach each one. You should periodically check the progress being made and confirm what the aides or tutors are doing. As an alternative, you may wish to work directly with the special needs students when needed. During these periods, it may be appropriate for aides and peer tutors to work with the other students in your class.

7. *What if the student attains all of the competencies listed in the IVEP and is capable of learning more?*

A meeting of the IEP/IVEP team is imperative. It may be advantageous to increase the number of competencies that the student can learn in Ag III for the occupation(s) previously identified. It may also be possible to increase the number of occupations for which the student is being prepared.

8. *Where can I get advice and assistance on working with special needs learners?*

Your first source of assistance and advice should be the district's vocational or special education administrator. The regional vocational education coordinator in your county's ESD is another source of advice and assistance on teaching special needs learners. Your regional coordinator should also be able to help you with developing IVEP and instructional teams within your school. If neither types of persons are available to you, contact the Agricultural Education Program at Oregon State University (phone: 754-2661) or the Vocational Education Special Needs Project (phone: 754-2586) for assistance with specific teaching methods and materials and with forming IVEP teams in your school.

Eliminating Sex Bias in Vocational Agriculture Class

Another goal of this curriculum guide was to assure that there was no sex-bias or sex-role-stereotyping in vocational agriculture classes. The following article by Paula Diperna entitled "Up On The Farm" was included so that the Vocational Agriculture teacher may use it to help students understand the problems of sex-bias and sex-role-stereotyping and as a recruiting tool to encourage young women to enter agricultural occupations.

Every effort has been made to remove sex-bias from the curriculum material contained in this package. As the instructor develops material to supplement this curriculum guide to meet local/regional needs they are encouraged to avoid sex-bias/sex-role-stereotyping.

Up On The Farm

by Paula Diperna

Most cityfolk tend to be naive about life down on the farm. They think of cows mooing, pigs oinking and chickens scratching around the barnyard. They also harbor images of farm women with their hair in buns, doing little more than churning butter and organizing quilting bees. However persistent these preconceptions are, reality simply does not bear them out. Agriculture is a complex and demanding science, offering a wide variety of career opportunities, and women are participating at every level in unprecedented numbers. Women now own farms, manage farms, loan money to farmers, promote farm products, write about farms, lobby farm issues, sell farm equipment and supplies, teach farming techniques, run farm machinery, plant, landscape, milk, work livestock and harvest crops. Female attendance at agricultural colleges has jumped radically, with some schools reporting 100 percent increase in just a few years' time. Today, women make up one-third of the undergraduate agricultural enrollment. The word is out--women on the farm are anything but down.

FEMALE FARM LABOR: THE BACKBONE OF AMERICAN AGRICULTURE

Women have been integral to the American agricultural process since the first seeds were sown in the new colonies. Farming then was a family proposition, and the farm woman usually was a wife who ran the household and pitched in with the chores--the stoic, hard-working, invariably dependable backbone of the family--farm unit. In fact, without female agri-labor, the rapid development of American agriculture never could have taken place.

It is interesting that women have always performed a wide variety of farm duties. Sherry Thomas, a former sheep rancher and coauthor of *Country Woman: A Handbook for the New Farmer*, is currently compiling an oral history by interviewing women who've been involved in agriculture for years. "I'm seeing that what is often regarded today as 'strange' behavior for women--like heavy farm work--has always been acceptable on the farm itself." Indeed, farm magazines in the less-than-liberated early 1900s ran numerous articles with titles such as "Beekeeping for Women"; "Three Women Who Make Mammoth Bronze Turkeys Pay Well"; "The Mistress of Overlook Farm." In 1907, a lengthly article in Farm and Fireside magazine explained: "Of late years, a constantly increasing number of women have graduated into the ranks of independent farmers, owning or leasing farms on their own responsibility and personally superintending every detail, from the purchase of the seeds to the marketing of the produce. The pioneers...are the widows of practical farmers [but they] have been joined in many localities by other women who have migrated from cities and towns...simply because they were convinced that the work would prove more congenial than any of the other occupations open to women."

These words might just as well have been written today about the many women actively involved in farm production, who have to be part scientist, part business whiz, part magician--and plenty on the ball.

TODAY'S WOMEN FARMERS: SHREWD AND PROFESSIONAL, 365 DAYS A YEAR

Kaye Fisher and Margaret (Maggie) Fessard, for example, run a 272-acre dairy farm in upstate New York with 100 head of registered Holstein cattle. The farmhouse is at least a century old, and the farm itself originally belonged to Fisher's grandfather. Fisher grew up on it and was right-hand helper until she went off to become a biology teacher. After two years in the classroom, she went back to take over the farm because she "just felt that was where I wanted to be." Fisher was not formally prepared for her new role. "There was a lot of things I'd never bothered to learn, or that my father hadn't bothered to teach me because nobody expected that eventually I'd be running the place." Fessar, also a teacher, and a city woman with absolutely no farming background, came down for a summer to visit and stayed on, learning by trial and error. Her initiation rite was to disc, or break up, a 40 acre pasture--a job considered to be one of a farmer's toughest on a tractor. She did it with no mishap. "I figured if I could do that, I could do anything," said Fessard.

Despite their lack of theoretical background, Fisher and Fessard have enjoyed considerable success. In the four and a half years they have run the farm, the milking herd has grown from 16 to 43 head. In addition, they breed cattle, board horses and grow all the feed -- except the protein supplements -- their animals consume. But admirer beware: They work extraordinarily hard.

The day, begun at 5:30 AM, 365 days a year, and ended at about 7 PM, is taken up with milking, feeding, barnyard and housekeeping, cropping, tending pasture, baling hay, etc., etc., etc. There is only one full-time worker-a male--though there are occasionally part-time workers.

The milking ritual is fascinating to watch. While Fassard cajoles the Holsteins back onto the milking area from the outdoor pastures, Fisher settles them into their stalls. She barely can be seen amongst the cows -- their shoulders are about even with her shoulders. Clearly each animal has an individual personality quirk, which is jokingly catered to, and each cow is called by name. In every aspect of their operation Fisher and Fessard project shrewd professionalism, efficiency and common sense. They have a good time, too, and so do the cows. Music is piped in during milking, and when I asked if it was for the cows' benefit, Fisher replied with a smile, "Well, we all enjoy it."

Fisher shudders at the thought of what the farm would be now if she hadn't taken it over. Not only would it have passed out of the family, also "the land would be lost, to agriculture, chopped into tiny tracts. Someone comes by almost every month to see if I'll sell off a piece." Not likely.

BEAUTIFUL OATS

Melda Snyder, of Flemington, New Jersey, has managed her farm alone for eleven years since her husband died. It's a magnificent 530-acre area, which grows corn, wheat, oats and alfalfa, and supports beef and dairy cattle. With eyes trained from years of experience, Snyder can spot a bad row of corn among fields of good ones. "Now here's a really sad bunch, but aren't those the most beautiful oats you've ever seen? I learned how to run things through osmosis, really. Clifford and I always made decisions together, so when the time came, I knew enough about the farm to keep it going."

Today, in addition to managing her farm, Snyder is vice-president of the New Jersey State Board of Agriculture and is a prime mover and shaker for farmers in the area. Though she is mainly concerned with farm management, she is still not above driving the hay wagons, and she radiates a farmer's free spirit and self-sufficiency. "People wonder why we farmers are so independent; well, it's a great relief to know you can grow your own food, if necessary."

Though Snyder holds a variety of degrees, has studied architecture and managed school systems, she said of her farm life style. "I simply couldn't live any other way and be happy."

GREENGROCERIES

From North Carolina, Dorothy MaClean Slade drives to New York City every week with her family to sell their produce in the flourishing Greenmarket. She apprears to love chatting with the shoppers who crowd the farmers' stalls, thrilled with the opportunity to buy directly from the farm. Her family has owned their farm for 40 years, and though Slade intended to be a nurse, she had to drop out of school for financial reasons and since has made a success of 300 cleared acres of land. "We grow everything you can name and love doing it. If my daughters want to take over the farm, that's great with me."

BIODYNAMIC FARMING

Of all these women, Anne Mendenhall has been actively farming the longest. She owns 280 acres near Aurora, New York and she capsulizes her 20-year career into a few lively sentences: "In 1958, I left my Madison Avenue ad-agency job and came up to Cornell to study farming. I lived on a poultry farm and got a scholarship to put myself through school. One of my professors told me that Iowa was a farmer's promised land, that it had the best of everything. So off I went. When the best of everything eluded me, I came back to the Itahaca area. This place has been owned by a professor; he died, and his wife decided to sell it. I didn't have any money to put up, but she sold it to me on faith; I've been here ever since." Today, Mendenhall champions biodynamic farming and brings skeptical neighbors around to see the results she has obtained by using no commericial fertilizers or pesticides whatsoever. When we pulled up alongside her field of soy beans in neat, full, green rows, one male neighbor took a long, thoughtfull look and said, with undeniable respect in his voice, "Well, I am impressed with those beans."

THE HIGH COST OF FARMING: HOW WOMEN ARE BEATING IT

Owning and operating a farm these days is far from simple, for men or women. Because land prices are now almost prohibitively high, most women who own their land have either inherited it or "married it." Equipment and supplies can run into thousands of dollars per year. In return for enormous capital and labor investment, the farmer receives a fraction of what the consumer spends on the food. Wheat growers argue, for example, that their grain pays them an amount equal to what it costs just to wrap loaves of bread in paper. Despite the odds, women who really want to farm can do so even without owning one. Some women, such as recently graduated Janet Gorst of upstate New York, job-hunt for farm work the way other women scout positons in business. Said Gorst: "My boss wanted someone who could do the job and was willing to learn new techniques. I tractor seed, do everything that I want to do."

Other women have joined in groups, like those who operate Critter Acres Farm in Penngrove, California. Cheryl Perry, who built up the business, rents land and leases a dairy along with two women friends, one of whom still holds down another job in order to pay farm bills. The farm produces goat milk and, so far, has held its own.

FARM - WOMEN'S LOBBIES: "IT'S ABOUT TIME WE HAVE SOMETHING!

In addition to farms actually run by women, there is an extraordinary upsurge in activity on the part of farm wives. Nancy Smidle of Kewauneed, Wisconsin, for example, convened American Agri-Women (AAW) for the first time in 1974. "It was about time we women had something, she said. "Most farm women know farm operations as well as' the men do." AAW, which now has 32 state chapters, 3,000 individual members and a total of 30,000 members--if you include affiliated women's organizations--serves as a powerful farm lobby. Other women's groups abound, and the newly formed Washington-based Rural American Women (RAW) has a task force at work developing action resolutions for women's agricultural issues.

Pursuing agricultural careers is not without the obstacles inherent when women chart paths previously assumed to be in the male domain. "You always have to work doubly hard to show you can do it," said one agriculture student. "Sometimes you get the feeling that the men don't really want you touching that valuable equipment," said another. Fisher suspects that her neighbors, who now are very supportive of her, originally believed she'd be out of business within a year. Other farm women complain that male workers have difficulty taking orders from females: "It's that Latin macho-American style," said one.

Women are proving by doing, though some hurdles require more concerted action. One of the primary focuses of women's lobby groups has been to challenge farm estate-tax laws. As written in most states, these laws view farm wives as the heirs of their husbands, not as their legal partners. Often, the death of a husband means a wife is liable for estate taxes, which could mean selling off the farm in order to pay them. Yet if a wife dies, no estate taxes are owed by the husband.

Legal convolutions vary from state to state and all farm women are advised to check their legal status and to plan estate transitions carefully. Joan Adams of Buffalo, Oklahoma, current president of AAW, said: "Unless a wife keeps a separate bank account and shows in dollars and cents what she has put into the farm, her work contribution means nothing to the IRS."

AGRICULTURE SCHOOLS AND FARMERS' GROUPS: WOMEN ARE GETTING PARITY

Colleges around the country are reevaluating their agriculture programs to provide curriculum equity for women, and Colorado State University held a recent conference expressly for that purpose. Well-established programs are also reflecting the new female ranks. Last summer, the Black Agriculturalists-a student group at Cornell's College of Agriculture and Life Sciences-operated a community garden for the Greater Ithaca Activities Center with an all-female staff-five young women, not all of whom had farm backgrounds. Witness Dinah Torres of Valley Stream, New York, who enrolled at Cornell because "agriculture has always seemed like a good thing to me."

This year, Cornell's entering class was 50 percent female, compared with 27 percent in 1967. Leslie Dines, who did her undergraduate work in environmental science and has general agricultural knowledge, was the college's first female recruiter. Her genuine enthusiasm and considerable energy make you wish you'd thought about an agriculture career yourself. To quote Dines, "If the 'hands-on' production farming seems too strenuous or demanding, there are many other routes to go. We are seeing women entering programs all across the curriculum."

Judy Massapny, director of information for the National Grange, agreed. "I don't know if we can say that more and more women are going into farming for themselves, but we certainly see many more women in the agriculture media, in sales promotion, in the research sciences and in the agri-businesses."

Almost no group attests to the growing role of women in agriculture as clearly as Future Farmers of America (FFA), an organization of high-school students preparing for agricultural careers, which for years actually barred women from entering. (They used to sneak in by registering with first initials only.) In 1969, reacting to the general pressure of the women's movement, the group opened its ranks to women, and today, approximately 15 percent of the 508,000 membership is female. Julie Smiley, who intends to make a career in agricultural journalism, was the first female national officer of FFA, followed by Peg Armstrong, a farmer national vice-president. Ten of the organization's 50 state presidents are female.

At a caucus of the young women delegates attending the group's recent conference in Washington, DC, nothing was as obvious as the diversity of their backgrounds. Some were born to the farm, but many others were city kids transplanted to the country, or ones who had chosen agriculture on their own. Each had an equally confident perspective: "Well, the time has come for women in agriculture, that's all," said one. "We can run things better than men, and they know it." quipped another.

President Carter, who had been an FFA member as a young man in Plains, spent 20 minutes with the entire FFA delegation at a special Rose Garden reception. He talked genuinely of their mutual love of the land, then shook hands and chatted with the delegates. One girl said the President looked slightly suprised to see her but, recovering, talked to her "farmer to farmer."

NEW RESPECT FOR AGRICULTURE: WOMEN ARE MAKING IT HAPPEN

Perhaps the most exciting aspect fo the women's movement in agriculture is the potential it has to draw together urban and rural people. As America begins to notice agri-women, it must begin to pay more careful attention to agriculture in general. The recent farmers' strike, consumer resistance to higher food prices and rising concern with food quality and food shortages have focused attention on the agricultural segment of the economy as never before. Jean Tetrault, coauthor with Sherry Thomas of Country Woman, predicts all this attention could lead to a "renaissance of the small farm." Perhaps she is overly optimistic, but at least we know that if women have anything to do with it, there will be a new respect for and appreciation of agriculture.

As Jill Beckman of Elgin, Nebraska expressed it, "I'd just like to say that I'm glad your're doing this article, because I grew up being embarrassed to say I lived on a farm." One hopes these insecurities are long in the past of American farm women. After all, if intelligent, dynamic women have chosen agriculture as a viable career alternative, there's assuredly more to it than ee-i-ee-i-o.

CAREERS IN FARMING

AGRICULTURAL PRODUCTION-THE REAL NITTY-GRITTY

Be warned. This aspect of farming is not for everyone. The hours are long, the work arduous and the financial rewards of a small farm are erratic and meager at first. Success is possible, but those who farm do so more for the sheer exhilaration of seeing things grow, for the thrill of being close to the land, than for the money that could be in it.

Credit

Though no real data on the subject exist, access to credit to start a farm should be as available to women as to men. In addition to commercial-bank loans (the American Banking Association reports that there are at least 40 female agricultural loan officers around the country), the federal government provides agricultural credit through the Federal Land Bank System, the Cooperative Farm Credit System and the Production Credit Association. For information write:

The Farm Credit Administration
Washington, DC 20578

Education

Learn about the aspect of farming that most interests you and, as Anne Mendenhall recommends, "take little steps first." All the land-grant colleges-schools which were set up in the 18th century to disseminate higher education-have schools of agriculture. There is a land-grant college in every state, and each one operated an extension service to provide outreach information from the colleges to interested farms. For information, write the land-grant college in your state.

AGRICULTURE-RELATED CAREERS

Here, the possibilities are numerous, not only for learning new skills, but also for applying old ones. Most of these jobs offer wide administrative, managerial and creative challenges. They include:

Agricultural Engineering - soil science, machinery design, farm waste management.

Agricultural Economics - farm management, business management, international economy, agri-banking.

Agricultural Science - biology, botany, ecology, genetics, breeding, forestry, animal science, equestrian science.

Environmental Science - landscape architecture, aquatic and atmospheric study, natural-resource management.

Food Science - nutrition, food analysis.

Plant Science - vegetable crops, field crops, horiculture, pomology, ornamental horticulture, floriculture, plant breeding.

Sociology and Behavior, Communicatons - rural studies, agri-journalism, product marketing, sales promotion, data collection.

Agricultural Education - teaching agricultural subjects.

For more information on careers in agriculture, write the college of your choice or:

National Association of Land-Grant Colleges
One Dupont Circle
Washington, DC 20036

PUBLICATIONS

The Department of Agriculture publishes numerous brochures on every aspect of agriculture, many of which are free. Write:

US Department of Agriculture
Publications Division, OPA
Washington, DC 20250

Also order a copy of the 1978 US Department of Agriculture Yearbook, entitled Making It on a Few Acres, from:

Superintendent of Documents
Government Printing Office
Washington, DC 20402

Another fine source of practical farming tips is Country Woman, by Sherry Thomas and Jean Tetrault, Anchor Press, 1976, $6.95.

Planned Course Statement

Department: Vocational Agriculture

Course title: Agriculture III (________________)
Alternate Title
(for the imaginative)

Course Number: ________________

Length of course: 36 weeks No. of Credits: 1 Grade Level: 11

Prerequisite: Ag II Credit by Exam Available ☐ yes ☐ no

Check one:
☐ Required
☐ Selective
☐ Elective

Alternate Learning Opportunities (check one or more)
☐ Does Not Apply
☐ Independent Study
☐ Off-Campus Experience
☑ Other (Explain in Course Overview)

Course Overview: The course will provide students who have a career interest in agricultural occupations fundamental concepts and skills necessary to begin specific employment preparation. Classroom instruction will be combined with laboratory activities and the Future Farmers of America (FFA) activities to enhance learning. Supervised Occupational Experienced Programs (SOEP) in the form of on the farm projects, cooperative work experience, agricultural services projects, and/or farm and/or homestead improvement projects are required of those students who participate in Agriculture III for the purpose of developing on-the-job skills and refining tentative career choices.

Program Goal at Agriculture III Level:

The student will:

1. Understand and explore basic agricultural principles and careers which impact production agriculture and agri-business occupations in the employment region served by the high school.
2. Begin preparation for entry into agricultural occupations in production agriculture and agri-business through the study of specific subject matter contained in the Agriculture III guide.
3. Make tentative career choices based on their abilities aptitudes, interests, values, and information learned in previous Vocational Agriculture classes.

Course Objectives:

Upon completion of Agriculture III the student will be able to :

1. Do differential land survey using levels and/or transits.
2. Use levels for building lay out.
3. Select appropriate instruments for various land measurement tasks.
4. Understand animal genetics and apply that understanding to farm breeding program development.
5. Know advantages and disadvantages of artificial insemination.
6. Develop herd breeding plans.
7. Identify common livestock and poultry diseases.
8. Know cause, symptom and cure for common animal and poultry diseases.
9. Understand basic principles of electricity.
10. Wire electrical circuits.
11. Maintain electric motors.
12. Plumb using steel pipe, copper, or plastic pipe.
13. Present an informative speech.
14. Complete records for an SOEP or CWE of students choice consistent with student occupational objective.
15. Complete various application forms such as State Farmer Degree, Proficiency Award, Loan, etc.
16. Do repair welding jobs on various kinds of metals.
17. Identify common metals used in agriculture.
18. Select electrodes appropriate to the type of metal to be repaired.
19. Set-up, maintain, adjust and/or calibriate agricultural tillage and planting equipment.
20. Know what equipment to use in given situations for correct tillage and planting operations.

21. Identify various cuts of meat and their quality.

22. Calculate yield grades of meat producing species.

23. Identify advantages and disadvantages of various berry species.

24. Know production practices for berries grown in the local area.

25. Identify various grass seed species.

26. Know production practices for grass seed grown in the local area.

27. Identify various nursery crops grown in the local area.

28. Know production practices for nursery crops grown locally.

29. Understand principles of landscape design.

30. Draw a landscape design applying principles and correct drawing practices.

31. Know production practices for Christmas trees grown in the local area.

32. Understand multiple use concepts of Range Management.

33. Know production practices and lease arrangements for range.

34. Understand the value of bees.

35. Know production practices for bees.

36. Perform chainsaw maintenance activities.

Learning Activities:

1. Individual and group projects.

2. Group discussions.

3. Teacher and resource person presentations.

4. Student presentations.

5. Problem solving activities.

6. Field trips to local Farms, Ranches, Agri-business, and Agricultural Shows and Fairs.

7. Viewing slides, films, and filmstrips.
8. Participation in classroom, district, sectional, state and national contests.
9. Completion of worksheets and study guides.
10. Participation in FFA meetings, activities and contests.
11. Participation in SOEP.
12. Keep accurate records of SOEP.
13. Participate in decision making process as applied to instructional areas and goal setting throughout the course.
14. Setting tentative occupational goals in agriculture and working toward them -- revising the goals as appropriate and changing direction.

Assessment Procedures:

1. Written and oral assignments.
2. Individual and group projects.
3. Written and performance tests.
4. Notebook of instructional material.
5. SOEP evaluation.
6. Observation by teacher.
7. One-to-one conferences between teacher and student.

Advanced Planning for Course

Some instructional materials must be ordered in the summer inorder to have them on hand when needed. Below is a list of early planning considerations.

1. Order films in June-July or earlier.
   Major free loan film companies are:

   a. The Farm Film Foundation
   1425 H. St., N.W.
   Washington, DC 20005

   b. Modern Talking Pictures Service, Inc.
   #16 Spear St.
   San Francisco, CA 94105

   c. Vernard Films Ltd.
   Box 1332
   Peoria, IL 61601

   d. Educational Films
   The Farm Credit Banks of Wichita
   151 North Main
   Wichita, Kansas 67202

   e. Safer Oregon
   Worker's Compenstaion Department
   Accident Prevention Division
   Labor and Industries Bldg.
   Salem, Oregon 97310

Write and get catalogs from these firms and place orders early. Instructional materials available include charts, pictures, informational data, films, and film strips.

1. Allis-Chalmers
Ideal Pictures Film Library
4431 West North Ave.
Milwaukee, WI 53208

2. Amchem Products, Inc.
Agricultural Division
Advertising Department
Ambler, PA 19002

3. American Cyanamid Co.
David Butterfield
Agricultural Division
P.O. Box 400
Princeton, NJ 08540

4. American Farm Bureau Federation
Information Division
225 Touhy Ave.
Park Ridge, IL 60068

5. American Quarter Horse Assn.
Film Reservations
2736 West 10th,
Armarillo, TX 97168

6. American Sheep Producers Council
200 Clayton
Denver, Colorado 80206

7. Armco Steel Corporation
Training Division
7000 Roberts St.
Kansas City, MO 64125

8. Audio Visual Productions, Inc.
1233 N. Ashland Ave.
Chicago, IL 60622

9. BASF Wyandotte Corporation
100 Cherry Hill Road
Parsippany, NJ 07054

10. Babson Bros.
Babson Bros. Company
2100 South York Road
Oak Brook, IL 60521

Addresses Continued:

11. Blue Anchor, Inc.
Walter Tindell
P.O. Box 15498
Sacramento, CA 95813

12. JI Case Co.
Ag. Equip. Division
700 State Street
Racine, WL 53404

13. Caterpillar Tractor Co.
100 N.E. Adams
Peoria, IL 61629

14. Deutz Corporation
7385 Pounce de Leon Circle
Atlanta, GA 30340

15. Dickey-john Corporation
Films
P.O. Box 10
Auburn, IL 62615

16. Dow Chemical U.S.A.
Film Library
P.O. Box 1706
Midland, ML 48640

17. E.I. Du Pont & Co.
Advertising Department
Audio Visual Section
Wilmington, DE 19698

18. Elanco
Annette Proctor, Film Library
Eli Lilly & Co.
Indianapolis, IN 46206

19. Elliott Films
2635 Nicollet Ave.
Minneapolis, MN 55408

20. Energy Film Library
DOE Technical Info Center
P.O. Box 62

21. The Farm Film Foundation
1425 H. St. N.W.
Washington, DC 20005

22. Farmbank Services
Joe Basher
12000 E. 47th Ave.
P.O. Box 39088
Second Floor
Denver, Colorado 80239

23. The Fertilizer Institute
1015 18th St. N.W.
Washington, DC 20036

24. Gehl Company
Marketing Services
143 Water Street
West Bend, WI 53095

25. Golden Harves Seeds, Inc.
Charles R. Finley, Exec. VP
513 E. Locust St.
Bloomington, IL 61701

26. Grain Terminal Association
P.O. Box 43594
167 Snelling Ave. N.
St. Paul, MN 55164

27. Grinnell Mutual Reinsurance C
Public Relations Department
1-80 at Highway 146
Grinnell, IA 50112

28. Gulf Oil Corporation
Public Relations Department
Gulf Building
Pittsburgh, PA 15230

29. Holstein-Friesen Association
Box 808
Brattleboro, Vermont 05301

30. ICI Americas Inc.
Wilmington, DE 19897

31. International Minerals &
Chem. Corp.
Audio Visual Department
501 E. Lange Street
Mundelein, IL 60060

32. International Harvester
Route 71 & Harvester Road
Sheridan, IL 60551

33. Iowa Farm Bureau Federation
Wendall Jarvis, Creative Visua
5400 University Ave.
West Des Moines, IA 50265

34. University of Iowa
Media Library
Iowa City, IA 52240

35. Kalo Laboratories, Inc.
9233 Ward Parkway
Kansas City, MO 64114

Addresses Continued:

36. Lindsay Manufaturing Co.
Russ Carlton, Adv & Promotion
Box 156
Lindsay, NE 68644

37. University of Maryland
Audio-Visual Services Dept.
Annapolis Hall
College Park, MD 20742

38. Modern Talking Picture Service Inc.
Rosanne Pollack
5000 Park St. N.
St. Petersburg, FL 33709

39. Monsanto Ag. Products
Larry Evetts
800 N. Lindbergh Blvd.
St. Louis, MO 63166

40. Nat. Cotton Council of Amer.
P.O. Box 12285
Memphis, TN 38112

41. Nat. Rural Electric Coop. Assn.
2000 Florida Ave. N.W.
Washington, DC 20009

42. North Dakota St. Film Library
North Dakota State University
Fargo, ND 58102

43. Occidental Chemical Co.
Public Relations Dept.
P.O. Box 196
Lathrop, CA 95330

44. Owatonna Man. Co., Inc.
Bob Duncan
P.O. Box 547, Hwy. 45 N.
Owatonna, MN 55060

45. Ralston Purina
Checkerboard Square
St. Louis, MO 63188

46. Roche Chemical Co.
340 Kingsland St.
Nutiey, NJ 07110

47. Rohm and Haas Company
Librarian
Independence Mall West.
Philadelphia, PA 19135

48. Shwartz Manufacturing,
Division of Chromalloy
129 Pine St. South
Lester Prairie, MN 55354

49. Select Sires Inc.
11740 U.S. 42
Plain City, OH 43064

50. Shell Firm Library
1433 Sadlier Circle W. Dr.
Indianapolis, IN 46239

51. Sioux City Livestock Market
News Foundation
128 Livestock Exchange Bldg.
Sioux City, IA 51107

52. Smith Kline Animal Health
Karol Media
933 Pacific Avenue
Kansas City, MO 66101

53. Bill Snyder Films, Inc.
Box 2784
Stoneville, MS 38776

54. Soil Enterprise Corp.
P.O. Box 128
Stoneville, MS 38776

55. Sperry New Holland
Public Relations Department
New Holland, PA 17557

56. Steiger Tractor Inc.
Box 6006
3101 1st Ave. North
Fargo, ND 58102

57. Tri-State Breeders Cooperative
Director of Public Relations
Westby, WI 54667

58. The Upjohn Company
Corporate Film Library
7000 Portage Road
Kalamazoo, ML 49001

59. USS Agri-Chemicals
Alan Kendall
P.O. Box 1685
Atlanta, GA 30301

60. Vermeer Manufacturing Co.
Jaap Kroes
Box 200
Pella, IA 50219

61. Washington State University
Instructional Materials Center
Pullman, WA 99164

Addresses Continued:

62. White Farm Equipment
Merchandising Department
2625 Butterfield Road
Oak Brook, IL 60521

2. Get current commodity date information sheets. Annually updated sheets are available in January from:

Stan Miles
219 Extension Hall
Oregon State University
Corvallis, Oregon 97331
(Phone 754-4821)

a. Get both, "Oregon's Leading Agricultural Commodities" and "Oregon Gross Farm Sales Preliminary Estimates".

b. Copies of 1982 data sheets are included in this packet as examples. Get up-dated sheets each January.

Prepared by Stanley D. Miles
Extension Economist, Oregon State University

The following pages contain estimates of agricultural production and value of farm and ranch sales for 1982. These are preliminary or first estimates and will be revised and updated as additional information is received. The estimates are made by Oregon State University Extension Service personnel. County Extension agents develop estimates of acreages, yields, prices, numbers of cattle, sheep, hogs, and poultry. After all the county reports are completed, state totals are tabulated by Oregon State University Extension economists.

This summary report provides a quick overview of Oregon agriculture for this past year. Oregon agricultural production information is requested by individuals, companies and agencies such as farmers and farm organizations, legislators, state and federal agencies, fertilizer and chemical companies, machinery companies, university specialists and administrators, students, consulting companies, news media, and other agribusiness firms.

The Extension Service maintains detailed information on Oregon and United States agriculture and publishes other reports. Each year we publish more than 50 Commodity Data Sheets on the major agricultural commodities produced in Oregon. These contain a county breakdown of production, data on other northwest states or states that are important in the particular commodity and total figures for the United States. These sheets contain data for the last 3 to 5 years.

Commodity data sheets are published in the following groupings: grains, hay, forage, grass and legume seeds, field crops, tree fruits and nuts, small fruits and berries, vegetable and truck crops, specialty products, and livestock and poultry. If you would like these reports or would like your name on a mailing list, please write to 219 Extension Hall, Oregon State University, Corvallis, Oregon 97331.

Ag III - a - 30

Oregon Gross Farm Sales, 1982 Preliminary

County	All Crops	All Livestock	Total
	Thousand dollars		
District 1.......	$ 520,826	$ 210,147	$ 730,973
Benton........	29,968	7,514	37,482
Clackamas.....	68,229	37,757	105,986
Lane..........	33,449	25,935	59,384
Linn..........	66,859	25,888	92,747
Marion........	148,190	49,968	198,158
Multnomah.....	30,363	2,926	33,289
Polk..........	33,546	14,219	47,765
Washington....	64,210	18,644	82,854
Yamhill.......	46,012	27,296	73,308
District 2.......	18,428	82,336	100,764
Clatsop.......	566	4,896	5,462
Columbia......	4,907	6,664	11,571
Coos..........	7,045	18,320	25,365
Curry.........	2,881	3,197	6,078
Lincoln.......	1,707	1,734	3,441
Tillamook.....	1,322	47,525	48,847
District 3.......	39,451	48,649	88,100
Douglas.......	14,476	18,580	33,056
Jackson.......	20,771	18,990	39,761
Josephine.....	4,204	11,079	15,283
District 4.......	278,146	66,704	344,850
Gilliam.......	19,124	4,045	23,169
Hood River....	28,788	2,319	31,107
Morrow........	68,397	22,958	91,355
Sherman.......	24,025	3,777	27,802
Umatilla......	104,401	23,134	127,535
Wasco.........	32,699	6,903	39,602
Wheeler.......	712	3,568	4,280
District 5.......	89,489	96,389	185,878
Baker.........	6,056	19,559	25,615
Malheur.......	58,889	56,425	115,314
Union.........	16,374	8,692	25,066
Wallowa.......	8,170	11,713	19,883
District 6.......	100,918	122,954	223,872
Crook.........	9,233	16,174	25,407
Deschutes.....	5,471	8,324	13,795
Grant.........	2,905	12,463	15,368
Harney........	4,738	18,680	23,418
Jefferson.....	28,203	9,985	38,188
Klamath.......	39,193	35,685	74,878
Lake..........	11,175	21,643	32,818
State Total......	1,047,258	627,179	1,674,437

December 1982

Oregon Gross Farm Sales, 1981-1982

Commodities	Thousand Dollars 1981r	Thousand Dollars 1982r	Percent Change
Grains	328,258	305,004	- 7.1
Hay and silage	55,207	68,824	+24.7
Grass and legume seeds	106,363	94,174	-10.9
Field crops	163,261	135,462	-18.0
Tree fruits and nuts	96,530	93,343	- 3.3
Small fruits and berries	35,490	48,679	+37.2
All vegetable crops	139,626	109,775	-21.4
Specialty products	212,169	191,997	- 9.5
All crops	1,136,904	1,047,258	- 7.9
Cattle and calves	295,000	309,323	+ 4.9
Dairy products	166,840	183,046	+ 9.7
Eggs and poultry	70,096	71,479	+ 2.0
Miscellaneous animals	66,081	63,331	- 4.2
All livestock and products	598,017	627,179	+ 4.9
Total gross sales	$1,734,921	$1,674,437	- 3.5

r - Revised. p - Preliminary.

Oregon's Leading Agricultural Commodities, Gross Farm Sales, 1982

Rank	Commodity	1982p	1981r	1980
		Thousand Dollars		
1.	Cattle and Calves	309,323	295,000	290,000
2.	Wheat	260,435	289,950	300,346
3.	Dairy	183,046	166,840	151,472
4.	Nursery Crops	85,110	91,140	85,500
5.	Potatoes	73,239	87,782	81,275
6.	Alfalfa Hay	53,411	42,900	54,846
7.	Chicken Eggs	36,362	31,507	27,141
8.	Farm Forest	29,235	50,400	56,065
9.	Christmas Trees	28,457	23,904	20,610
10.	Sweet Corn Processed	27,699	21,681	18,224
11.	Strawberries	27,477	18,126	15,333
12.	Barley	27,282	25,285	25,100
13.	Broilers	26,756	28,512	23,342
14.	Perennial Ryegrass	24,746	28,770	24,325
15.	Annual Ryegrass	24,414	29,440	22,440
16.	Snap Beans, Processed	24,382	23,826	24,874
17.	Winter Pears	23,505	25,454	24,240
18.	Sweet Cherries	21,480	20,128	15,900
19.	Sheeps & Lambs	19,457	17,500	16,142
20.	Hops	19,259	19,195	17,371
21.	Hogs	18,524	18,349	15,901
22.	Greenhouse Crops	18,385	17,115	14,899
23.	Peppermint	14,837	21,736	24,300
24.	Apples	14,028	17,682	14,820
25.	Filberts	13,930	11,319	17,380
26.	Dry Onions	10,939	49,472	[illegible]
27.	Corn for Grain	9,293	5,639	2,934
28.	All Kentucky Bluegrass	9,255	11,189	11,642
29.	Horses	9,212	10,166	7,447
30.	Sugarbeets for Sugar	8,846	8,849	8,333
31.	Hay (Other than alfalfa)	8,593	6,885	7,600
32.	Turkeys	7,760	9,500	10,004
33.	Bartlett Pears	7,712	9,805	13,604
34.	Oats	7,634	7,015	6,319
35.	Red Raspberries	7,428	6,144	3,042
36.	Orchardgrass	6,376	4,680	6,792
37.	Vegetables and Flower Seed	6,057	4,611	3,688
38.	Corn Silage	5,308	4,154	4,527
39.	Mink	5,794	6,669	5,958
40.	Green Peas	5,034	7,404	9,363

p - Preliminary. r - Revised.

Oregon's Leading Agricultural Commodities, Gross Farm Sales, 1982, continued

Rank	Commodity	Thousand Dollars 1982p	 1981r	 1980
41.	Red Clover	4,977	4,520	4,032
42.	Bentgrass	4,853	5,616	6,854
43.	Sugarbeet for Seed	4,840	6,470	4,312
44.	Cranberries	4,319	3,811	2,764
45.	Cauliflower, Processed	4,239	2,730	2,629
46.	Broccoli, Processed	4,157	1,699	1,468
47.	Chewings Fescue	4,122	5,278	7,075
48.	Tame Blackberries	3,976	3,150	5,875
49.	Tall Fescue	3,767	2,657	2,618
50.	Peaches	3,647	3,286	2,899
51.	Bulbs	2,625	3,425	3,195
52.	Squash & Pumpkins	3,313	2,584	2,029
53.	Cucumbers, Processed	3,085	3,385	2,712
54.	Prunes & Plums	3,081	3,458	5,250
55.	Grapes	3,021	2,338	2,091
56.	Blueberries	2,999	2,173	1,410
57.	Red Fescue	2,792	3,581	4,200
58.	Dry Field Peas	2,776	2,469	2,628
59.	Garlic	2,581	1,242	1,145
60.	Alfalfa Seed	2,289	4,145	5,415
61.	Cabbage	2,181	2,421	2,094
62.	Sweet Corn, Fresh	2,149	2,127	2,023
63.	Spearmint for Oil	2,070	1,725	1,470
64.	Cauliflower, Fresh	2,041	1,888	1,520
65.	Beets, Processed	2,018	2,011	2,138
66.	Carrots, Processed	1,831	1,696	925
67.	Carrots, Fresh	1,810	2,889	2,225
68.	Walnuts	1,758	1,225	1,425
69.	Wool	1,696	3,406	3,220
70.	Honey & Beeswax	1,597	1,534	1,264
71.	Crimson Clover	1,455	2,520	1,433
72.	White Clover & Ladino	1,396	1,085	1,037
73.	Tomatoes	1,349	1,235	925
74.	Austrian Peas	1,281	1,348	1,254
75.	Lettuce	1,251	1,958	1,862
76.	Turkey Eggs	1,148	2,346	2,459
78.	Boysenberries	1,113	1,185	1,085
79.	Rabbits	1,106	1,027	1,011
80.	Asparagus	1,104	1,119	582
81.	Watermelon	1,063	1,570	1,280
82.	Hairy Vetch	1,058	1,216	868
Other commodities		46,483	53,650	39,478
Total Gross Farm Sales		$1,674,437	$1,734,921	$1,663,428

p - Preliminary. r - Revised.

Oregon Agriculture Preliminary Estimates, 1982

Commodity	Area harvested	Yield per acre	Production	Price	Value of production	Percent sold	Value of sales
Grains:	Acres	Bushels	Bushels	Bushel	Thousands	Percent	Thousands
Wheat..................	1,261,550	55	69,046,400	$ 3.88	$267,739	97	$260,435
Barley.................	235,400	61	14,365,600	2.19	31,424	87	27,282
Oats...................	70,250	83	5,798,200	1.75	10,118	75	7,634
Other grains...........	38,850		4,838,900		12,259		9,653
Subtotal............	1,606,050		94,049,100		$ 321,540		$ 305,004
Hay and forages:		Ton	Ton	Ton			
Alfalfa hay............	435,950	4.0	1,762,020	$ 73.20	$129,035	41	53,411
Other hay..............	654,550	1.8	1,148,890	53.80	61,867	14	8,593
Corn silage............	30,950	23.1	715,200	20.10	14,356	37	5,308
Other forage...........	13,400		56,800		2,124		1,572
Subtotal............	1,134,850		3,682,910		$207,382		68,824
Grass and legume seeds:		Pounds	Thousand Pounds	Hundred-weight			
Alfalfa seed...........	6,820	420	2,836	$ 80.70	$ 2,289	100	2,289
Bentgrass seed.........	18,200	390	7,059	68.75	4,853	100	4,853
All K. bluegrass seed..	25,930	710	18,539	49.90	9,255	100	9,255
Red clover seed........	21,430	320	6,847	74.60	5,110	97	4,977
Chewings fescue seed...	14,900	630	9,449	43.60	4,122	100	4,122
Red fescue seed........	10,330	630	6,536	42.70	2,792	100	2,792
Annual ryegrass seed...	116,900	1,580	184,740	13.20	24,414	100	24,414
Perennial ryegrass seed	78,750	870	68,437	36.20	24,746	100	24,746
Orchardgrass seed......	19,350	820	15,940	40.00	6,376	100	6,376
Other seeds............	50,350		36,491		10,462		10,350
Subtotal............	362,960		356,874		$ 94,419		$ 94,174

Oregon Agriculture Preliminary Estimates, 1982, continued

Commodity	Area harvested	Yield per unit	Production	Price	Value of production	Percent sold	Value of sales
Field crops:	Acres	Units	Thousand units	Per unit	Thousands	Percent	Thousands
Potatoes..................	54,820	400 cwt	21,782 cwt	$ 3.70	$ 80,207	91	$ 73,239
Peppermint for oil.........	27,040	64 lbs	1,718 lbs	8.65	14,837	100	14,837
Hops.......................	7,550	1,710 lbs	12,880 lbs	1.50	19,259	100	19,259
Sugarbeets for sugar.......	10,300	26.0 ton	268 ton	33.00	8,846	100	8,846
Dry field beans............	7,370	20.0 cwt	147 cwt	11.20	1,656	100	1,656
Sugarbeet for seed.........	4,345	2,780 lbs	12,099 lbs	.40	4,840	100	4,840
Vegetable and flower seed..	2,560				6,057	100	6,057
Other field crops..........	30,825				8,651		6,728
Subtotal................	144,810				$144,353		$135,462
Tree fruits and nuts:							
Apples.....................	9,003	342 bxs	3,079 bxs	$ 4.55	$ 14,028	100	$ 14,028
Sweet cherries.............	14,038	2.8 ton	40 ton	540.00	21,480	100	21,480
Peaches....................	1,720	163 bxs	281 bxs	13.00	3,647	100	3,647
Bartlett pears.............	7,855	8.3 ton	65 ton	119.00	7,712	100	7,712
Winter pears...............	11,592	8.3 ton	96 ton	246.00	23,505	100	23,505
Prunes and plums...........	5,401	4.1 ton	22 ton	139.00	3,081	100	3,081
Filberts...................	22,459	1,850 lbs	35,720 lbs	.39	13,930	100	13,930
Other tree fruits and nuts.	5,909				5,960		5,960
Subtotal................	77,977				$ 93,343		$ 93,343

Ag III - a - 35

Small fruits and berries:	Acres	Units	Thousand units	Per unit	Thousands	Percent	Thousands
Strawberries	6,095	10,600 lbs	65,203 lbs	$ .42	$ 27,477	100	$ 27,477
Red raspberries	2,255	5,130 lbs	11,561 lbs	.64	7,428	100	7,428
Tame blackberries	2,715	7,310 lbs	18,928 lbs	.21	3,976	100	3,976
Other small fruits and berries	4,295		109,298 lbs		9,798		9,798
Subtotal	15,360		204,990 lbs		$ 48,679		$ 48,679
Vegetables and truck crops:							
Dry onions	10,370	485 cwt	5,014 cwt	$ 2.50	$ 12,469	88	$ 10,939
Snap beans, processed	26,860	5.3 ton	143 ton	170.50	24,382	100	24,382
Sweet corn, processed	42,500	9.1 ton	385 ton	72.00	27,699	100	27,699
Green peas	32,396	.9 ton	29 ton	176.10	5,034	100	5,034
Other truck crops	22,150				41,721	100	41,721
Subtotal	134,276				$109,775		$ 109,775
Speciality products:							
Nursery crops					$ 85,110	100	$ 85,110
Bulbs					3,625	100	3,625
Greenhouse crops					18,385	100	18,385
Turf sod					265	100	265
Farm forest products					29,235	100	29,235
Christmas trees					28,457	100	28,457
Other speciality products					26,920	100	26,920
Subtotal					$191,997		$ 191,997
Total all crops sales, preliminary estimate for 1982							$1,047,258

Oregon Agriculture Preliminary Estimates, 1982

Commodity	Number of inventory January 1	Quantity sold	Value of sales
Livestock and poulty:	Head	Units	Thousands
Beef cows and heifers..	706,800		
Cattle and calves......	1,703,200		$ 309,323
Hogs and pigs..........	99,400	152,600 hd	18,524
Sheep and lambs........	525,400		19,457
Dairy products.........	98,850 (cows)	13,098,000 cwt	183,046
Broilers...............		16,800,000 hd	26,756
Turkeys................		1,058,000 hd	7,760
Chicken eggs...........	3,089,500 (layers)	62,973,000 doz sold	36,362
Wool...................	610,800 (sheep shorn)	3,554,000 lbs mrktd	1,696
Mink...................	42,900		5,794
Horses and mules.......	143,600		9,212
Honey and beeswax......	57,100 (colonies)		1,597
Other miscellaneous livestock...........			7,652
Total livestock and poultry agricultural sales, preliminary estimates for 1982			$ 627,179
Total agricultural sales, preliminary estimate for 1982			$1,674,437

Ag III - a - 38

1981
OREGON GROSS FARM SALES
Revised Estimates

thousand dollars

District & county	Grains	Hay & silage	Grass & legume seeds	Field crops	Tree fruits & nuts	Small fruits & berries	All vegetable crops	Specialty products	All crops	Cattle & calves	Dairy products	Eggs & poultry	Misc. animals	All livestock & products	Total gross income
The State....	328,258	55,207	106,363	163,261	96,530	35,490	139,626	212,169	1,136,904	295,000	166,840	70,096	66,081	598,017	1,734,921
District 1...	61,186	7,803	90,369	41,217	26,446	29,663	88,306	162,879	507,869	35,717	75,395	62,338	31,428	204,878	712,747
Benton.....	3,753	456	7,014	2,478	562	638	4,686	8,675	28,262	1,957	3,715	206	1,316	7,194	35,456
Clackamas..	4,492	789	3,279	1,039	2,450	4,845	11,242	38,180	66,316	5,441	6,829	17,729	8,643	38,642	104,958
Lane.......	4,443	358	5,037	3,789	2,753	738	7,353	11,250	35,721	6,222	7,311	9,845	1,863	25,241	60,962
Linn.......	7,782	1,043	45,528	4,680	738	1,381	5,481	4,144	70,777	5,727	8,660	5,077	6,819	26,283	97,060
Marion.....	10,487	1,446	15,669	24,148	5,031	9,326	38,682	40,020	144,809	6,014	21,332	12,007	4,729	44,082	188,891
Multnomah..	545	76	96	335	143	3,531	6,980	21,290	32,996	1,002	1,595	11	601	3,209	36,205
Polk.......	9,858	715	5,422	3,159	3,717	721	1,941	5,155	30,688	2,577	5,077	5,272	1,591	14,517	45,205
Washington.	7,115	1,830	4,485	1,147	5,203	7,670	6,468	24,945	58,863	3,150	11,855	642	2,195	17,842	76,705
Yamhill....	12,711	1,090	3,839	442	5,849	813	5,473	9,220	39,437	3,627	9,021	11,549	3,671	27,868	67,305
District 2...	650	412	41	58	39	5,178	187	14,517	21,082	16,908	53,261	305	6,038	76,512	97,594
Clatsop....	---	62	---	---	---	74	5	1,000	1,141	1,289	2,011	9	1,872	5,181	6,322
Columbia...	650	126	41	37	20	1,221	92	2,800	4,987	3,150	2,933	[illegible]	462	6,554	11,541
Coos.......	---	93	---	---	14	3,447	10	4,977	8,541	4,868	11,382	266	1,342	17,858	26,399
Curry......	---	18	---	---	5	351	---	2,990	3,364	1,623	876	5	993	3,497	6,861
Lincoln....	---	27	---	---	---	57	50	1,450	1,584	1,047	309	16	340	1,712	3,296
Tillamook..	---	86	---	21	---	28	30	1,300	1,465	4,931	35,750	---	1,029	41,710	43,175
District 3...	2,086	1,400	508	1,386	17,522	369	1,919	17,198	42,388	20,584	14,634	4,186	6,741	46,145	88,533
Douglas....	1,216	435	153	36	2,390	345	1,470	12,010	18,055	10,194	1,264	707	4,309	16,474	34,529
Jackson....	828	699	355	192	14,867	24	352	3,154	20,471	8,099	5,842	3,334	1,735	19,010	39,481
Josephine..	42	266	---	1,158	265	---	97	2,034	3,862	2,291	7,528	145	697	10,661	14,523
District 4..	206,173	12,216	1,070	55,576	50,733	264	11,553	4,770	342,355	47,060	1,661	2,411	9,318	60,450	402,805
Gilliam....	22,898	246	174	173	---	---	---	10	23,501	4,296	---	---	190	4,486	27,987
Hood River.	---	103	---	---	33,661	98	87	770	34,719	699	498	480	449	2,126	36,845
Morrow.....	43,876	6,151	---	35,084	99	---	137	610	85,957	8,517	428	---	1,385	10,330	96,287
Sherman....	29,164	48	---	40	16	---	---	---	29,268	1,731	---	1,922	138	3,791	33,059
Umatilla...	87,873	5,012	896	20,160	6,128	166	11,227	2,830	134,292	22,367	735	6	5,763	28,871	163,163
Wasco......	21,913	601	---	---	10,829	---	102	400	33,845	5,823	---	3	1,089	6,915	40,760
Wheeler....	449	55	---	119	---	---	---	150	773	3,627	---	---	304	3,931	4,704
District 5...	36,365	6,516	8,460	33,619	1,521	16	37,238	6,190	129,925	81,232	14,784	26	4,640	100,682	230,607
Baker......	2,911	1,073	50	154	22	---	---	2,160	6,370	17,659	2,380	3	832	20,874	27,244
Malheur....	15,379	3,753	3,052	31,963	224	16	37,211	100	91,698	47,728	11,680	11	1,475	60,894	152,592
Union......	12,191	708	5,358	680	1,275	---	---	2,130	22,342	5,727	572	9	1,455	7,763	30,105
Wallowa....	5,884	982	---	822	---	---	27	1,800	9,515	10,118	152	3	878	11,151	20,666
District 6...	21,798	26,860	5,915	31,405	269	---	423	6,615	93,285	93,499	7,105	830	7,916	109,350	202,635
Crook......	1,032	4,711	154	2,722	---	---	8	250	8,877	11,359	565	33	472	12,429	21,306
Deschutes..	622	1,690	113	1,196	---	---	---	950	4,571	4,023	2,225	21	1,719	7,988	12,559
Grant......	285	827	---	338	269	---	---	1,260	2,979	9,268	---	41	1,804	11,113	14,092
Harney.....	1,163	2,544	36	126	---	---	---	10	3,879	18,805	---	---	501	19,306	23,185
Jefferson..	8,454	1,521	5,564	11,651	---	---	415	175	27,780	8,018	---	3	1,227	9,248	37,028
Klamath....	8,427	9,388	20	15,046	---	---	---	3,850	36,731	25,321	4,240	732	1,604	31,897	68,628
Lake.......	1,815	6,179	28	326	---	---	---	120	8,468	16,705	75	---	589	17,369	25,837

SOURCE: Compiled by Extension Economic Information Office, Oregon State University.

1982
OREGON GROSS FARM SALES
Preliminary Estimates

District & county	Grains	Hay & silage	Grass & legume seeds	Field crops	Tree fruits & nuts	Small fruits & berries	All vegetable crops	Specialty products	All crops	Cattle & calves	Dairy products	Eggs & poultry	Misc. animals	All livestock & products	Total gross income
	thousand dollars														
The State....	305,004	68,824	94,174	135,462	93,343	48,679	109,775	191,997	1,047,258	309,323	183,046	71,479	63,331	627,179	1,674,437
District 1...	77,891	10,479	81,810	36,227	28,217	41,456	86,536	158,210	520,826	35,408	82,166	63,543	29,030	210,147	730,973
Benton.....	4,399	577	6,462	2,362	776	836	5,456	9,100	29,968	2,216	3,780	213	1,305	7,514	37,482
Clackamas..	7,843	885	2,534	1,105	2,673	7,369	10,910	34,910	68,229	4,924	7,426	18,052	7,355	37,757	105,986
Lane.......	5,122	511	4,787	3,094	2,788	842	7,050	9,255	33,449	6,655	7,830	9,572	1,878	25,935	59,384
Linn.......	9,404	1,299	40,844	3,305	927	1,949	6,231	2,900	66,859	5,409	9,045	5,047	6,387	25,888	92,747
Marion.....	14,937	2,089	13,250	21,645	4,955	11,741	36,595	42,978	146,190	6,248	24,613	14,606	4,501	49,968	198,158
Multnomah..	662	106	87	338	147	4,125	6,411	18,487	30,363	721	1,635	11	559	2,926	33,289
Polk.......	11,530	992	5,953	3,098	3,297	964	2,547	5,165	33,546	2,620	4,987	5,145	1,467	14,219	47,765
Washington.	9,712	2,797	4,636	956	6,438	12,563	4,858	22,250	64,210	2,803	13,400	402	2,039	18,644	82,854
Yamhill....	14,282	1,223	3,257	324	6,216	1,067	6,478	13,165	46,012	3,812	9,450	10,495	3,539	27,296	73,308
District 2...	1,040	459	47	61	48	6,266	360	10,147	18,428	16,933	59,754	310	5,339	82,336	100,764
Clatsop....	---	74	---	---	---	87	5	400	566	1,114	2,086	9	1,687	4,896	5,462
Columbia...	1,040	167	47	42	29	1,764	40	1,778	4,907	3,315	2,940	9	400	6,664	11,571
Coos.......	---	88	---	---	14	3,904	235	2,804	7,045	4,586	12,290	274	1,170	18,320	25,365
Curry......	---	20	---	---	5	406	---	2,450	2,881	1,450	904	6	837	3,197	6,078
Lincoln....	---	26	---	---	---	66	50	1,565	1,707	1,126	308	12	288	1,734	3,441
Tillamook..	---	84	---	19	---	39	30	1,150	1,322	5,342	41,226	---	957	47,525	48,847
District 3...	2,727	1,824	484	1,204	18,122	429	2,221	12,440	39,451	21,936	15,134	4,422	7,157	48,649	88,100
Douglas....	1,800	478	152	25	2,593	374	1,544	7,510	14,476	12,191	986	714	4,689	18,580	33,056
Jackson....	762	788	332	189	15,140	55	575	2,930	20,771	7,573	6,048	3,556	1,813	18,990	39,761
Josephine..	165	558	---	990	389	---	102	2,000	4,204	2,172	8,100	152	655	11,079	15,283
District 4..	166,659	13,697	672	36,729	45,106	510	10,983	3,790	278,146	53,447	1,767	2,222	9,268	66,704	344,850
Gilliam....	18,400	241	165	308	---	---	---	10	19,124	3,857	---	---	188	4,045	23,169
Hood River.	---	131	---	---	27,531	134	102	890	28,788	852	508	496	463	2,319	31,107
Morrow.....	38,109	7,234	38	22,194	88	40	524	170	68,397	20,977	469	---	1,512	22,958	91,355
Sherman....	23,801	64	---	160	---	---	---	---	24,025	1,988	---	1,711	78	3,777	27,802
Umatilla...	67,202	5,119	469	13,957	5,037	320	10,197	2,100	104,401	16,834	790	15	5,495	23,134	127,535
Wasco......	18,727	801	---	---	12,450	16	160	545	32,699	5,691	---	---	1,212	6,903	39,602
Wheeler....	420	107	---	110	---	---	---	75	712	3,248	---	---	320	3,568	4,280
District 5...	32,394	8,120	5,713	30,765	1,545	18	8,354	2,580	89,489	75,132	16,317	26	4,914	96,389	185,878
Baker......	3,135	1,557	45	218	21	---	---	1,080	6,056	16,319	2,430	3	807	19,559	25,615
Malheur....	14,456	4,820	1,789	29,214	223	18	8,324	50	58,889	42,013	12,969	11	1,432	56,425	115,314
Union......	9,325	734	3,879	685	1,301	---	---	450	16,374	5,976	870	9	1,837	8,692	25,066
Wallowa....	5,483	1,009	---	648	---	---	30	1,000	8,170	10,824	48	3	838	11,713	19,883
District 6...	24,293	34,245	5,448	30,476	305	---	1,321	4,830	100,918	106,467	7,908	956	7,623	122,954	223,872
Crook......	1,220	4,680	176	2,861	---	---	36	260	9,233	15,238	493	18	425	16,174	25,407
Deschutes..	524	2,146	95	1,736	---	---	---	970	5,471	4,100	2,533	17	1,674	8,324	13,795
Grant......	366	1,354	---	320	305	---	---	560	2,905	10,588	---	54	1,821	12,463	15,368
Harney.....	1,148	3,299	76	205	---	---	---	10	4,738	18,133	---	---	547	18,680	23,418
Jefferson..	9,952	1,998	5,060	9,783	---	---	1,285	125	28,203	8,825	157	3	1,000	9,985	38,188
Klamath....	9,459	11,615	20	15,264	---	---	---	2,835	39,193	28,574	4,725	864	1,522	35,685	74,878
Lake.......	1,624	9,153	21	307	---	---	---	70	11,175	21,009	---	---	634	21,643	32,818

SOURCE: Compiled by Extension Economic Information Office, Oregon State University.

HARVESTED ACREAGE SUMMARY*
Oregon Counties, 1981

Countries	Grains	Hay & forage	Grass & leg seeds	Field crops	Tree Fr. & nuts	Sm Fru & ber	All Veg crops	Spec. Products	TOTAL
STATE TOTAL	1,597,900	1,114,500	348,705	154,365	79,548	15,046	126,608	2,372	3,439,122
District 1	326,300	174,500	309,340	35,360	40,623	13,395	82,007	1,972	983,547
Benton	18,650	11,900	24,200	2,850	578	205	6,376	540	65,305
Clackamas	31,200	26,200	11,070	600	3,710	2,590	5,935	520	81,830
Lane	24,700	23,300	17,360	5,530	3,800	320	9,225	100	84,340
Linn	40,000	26,400	152,590	7,100	855	510	6,715	122	234,302
Marion	58,400	22,000	45,380	15,230	6,700	4,632	38,889	270	191,500
Multnomah	3,900	3,300	400	250	140	1,260	2,505	10	11,770
Polk	52,400	14,700	22,210	2,390	5,885	338	2,845	270	101,100
Washington	35,350	24,700	19,100	1,030	9,745	3,020	3,292	100	96,340
Yamhill	61,700	22,000	17,030	330	9,210	470	6,225	40	117,060
District 2	4,300	37,200	220	90	32	1,366	120	70	43,400
Clatsop	---	4,000	---	---	---	28	---	---	4,030
Columbia	4,300	8,750	220	70	32	450	120	50	13,990
Coos	---	12,450	---	---	---	758	---	10	13,220
Curry	---	2,500	---	---	---	90	---	---	2,590
Lincoln	---	3,000	---	---	---	30	---	10	3,040
Tillamook	---	6,500	---	20	---	10	---	---	6,530
District 3	15,350	83,750	750	1,245	12,947	158	1,030	150	115,390
Douglas	10,100	47,200	270	55	2,100	145	805	90	60,775
Jackson	4,900	27,500	480	260	10,658	13	183	40	44,035
Josephine	350	9,050	---	930	189	---	42	20	10,580
District 4	941,500	124,100	2,800	45,690	24,802	122	32,091	150	1,171,260
Gilliam	136,300	7,600	470	430	---	---	---	---	144,800
Hood River	---	2,150	---	---	15,250	42	26	---	17,470
Morrow	219,400	30,700	---	27,250	40	---	80	150	277,620
Sherman	150,900	950	---	250	12	---	---	---	152,110
Umatilla	334,600	57,700	2,330	17,660	3,605	80	31,962	---	447,940
Wasco	96,600	13,000	---	---	5,895	---	23	---	115,520
Wheeler	3,700	12,000	---	100	---	---	---	---	15,800
District 5	182,750	230,600	18,275	41,840	1,010	5	11,080	---	485,565
Baker	19,250	72,500	150	330	20	---	---	---	92,250
Malheur	59,300	97,100	7,250	38,610	140	5	11,020	---	213,425
Union	66,500	31,000	10,875	2,500	850	---	---	---	111,730
Wallowa	37,700	30,000	---	400	---	---	60	---	68,160
District 6	127,700	464,350	17,320	30,140	134	---	280	30	639,950
Crook	4,200	46,500	550	2,900	---	---	---	---	54,150
Deschutes	3,350	22,700	370	1,050	---	---	---	---	27,470
Grant	2,550	46,000	---	580	134	---	---	---	49,260
Harney	16,600	131,000	1,500	120	---	---	---	---	149,220
Jefferson	32,500	17,150	14,820	15,930	---	---	280	30	80,710
Klamath	44,000	71,000	---	9,000	---	---	---	---	124,000
Lake	24,500	130,000	80	560	---	---	---	---	155,140

*Acreage estimates are not included for many specialty crops, pastures and rangeland areas. Some numbers may not add due to roundings.

SOURCE: Compiled by Extension Economic Information Office, Oregon State University. December 1982

HARVESTED ACREAGE SUMMARY*

Oregon Counties, 1982

Counties	Grains	Hay & forage	Grass & leg seeds	Field crops	Tree Fr & nuts	Sm Fru & ber	All Veg crops	Spec Products	Total
District 1	312,850	178,300	326,660	26,865	39,601	13,623	85,488	2,115	985,540
Benton	17,150	12,100	25,900	2,040	613	220	6,103	590	64,710
Clackamas	31,100	26,200	10,900	620	3,835	2,820	6,876	520	82,880
Lane	21,700	26,400	18,680	4,720	3,805	315	7,765	130	83,525
Linn	36,600	27,500	166,940	4,805	885	535	6,790	125	244,190
Marion	57,750	22,300	43,160	11,220	6,775	4,360	41,514	310	137,390
Multnomah	3,300	3,300	400	300	123	1,235	2,765	10	11,435
Polk	51,400	14,800	23,390	1,870	5,530	408	3,130	290	100,820
Washington	33,350	23,800	20,910	1,030	9,205	3,270	3,945	100	95,620
Yamhill	60,500	21,900	16,380	260	8,830	460	6,600	40	114,970
District 2	4,300	37,800	220	110	32	1,422	---	180	44,065
Clatsop	---	4,100	---	---	---	28	---	---	4,130
Columbia	4,300	8,700	220	90	32	490	---	50	13,880
Coos	---	12,500	---	---	---	763	---	10	13,275
Curry	---	2,500	---	---	---	90	---	110	2,700
Lincoln	---	3,000	---	---	---	35	---	10	3,045
Tillamook	---	7,000	---	20	---	16	---	---	7,035
District 3	16,450	84,000	800	680	12,142	148	1,305	170	115,720
Douglas	10,600	47,200	320	25	2,105	130	855	90	61,340
Jackson	4,900	27,600	480	105	9,848	18	413	40	43,410
Josephine	950	9,200	---	550	189	---	37	40	10,970
District 4	954,850	114,050	2,170	49,200	25,040	162	35,524	70	1,181,080
Gilliam	145,250	6,150	470	1,050	---	---	---	---	152,920
Hood River	---	2,150	---	---	15,210	37	59	---	17,455
Morrow	223,150	29,500	180	27,000	170	20	565	60	280,650
Sherman	150,200	1,550	---	480	---	---	---	---	152,230
Umatilla	332,650	49,700	1,520	20,570	3,755	100	34,867	---	443,170
Wasco	99,900	12,000	---	---	5,905	5	33	10	117,855
Wheeler	3,700	13,000	---	100	---	---	---	---	16,800
District 5	182,550	230,700	15,720	36,400	1,010	5	11,179	---	477,565
Baker	19,850	72,600	150	500	20	---	---	---	93,120
Malheur	66,000	97,100	5,180	32,650	140	5	11,119	---	212,195
Union	59,000	31,000	10,390	2,850	850	---	---	---	104,090
Wallowa	37,700	30,000	---	400	---	---	60	---	68,160
District 6	134,950	490,100	17,390	31,555	152	---	780	50	674,980
Crook	4,400	48,000	610	3,375	---	---	20	---	56,410
Deschutes	3,250	22,700	300	1,320	---	---	---	---	27,570
Grant	2,500	46,500	---	500	152	---	---	---	49,650
Harney	17,200	142,650	4,000	120	---	---	---	---	163,970
Jefferson	39,000	12,250	12,400	13,580	---	---	760	50	78,040
Klamath	49,200	71,000	---	12,000	---	---	---	---	132,200
Lake	19,400	147,000	80	660	---	---	---	---	167,140
STATE TOTAL	1,605,950	1,134,950	362,960	144,810	77,977	15,360	134,276	2,585	3,478,950

*Some totals may not add due to roundings. Acreage estimates are not included for many specialty crops, pastures and rangeland areas.

SOURCE: Compiled by Extension Economic Information Office, Oregon State University.

December 1982

3. Breed Association Addresses:

Breed association addresses are printed each year in "Agri-Educator". "Agri-Educator" is published twice yearly and can be obtained from the following address:

Agri-Educator
5520-G Touhy Ave.
Skokie, IL 60076

4. Breed Identification Slides
   a. Up-to-date breed identification slides are available from:
      1. Vocational Instructional Services
         F.E. Box 182
         Texas A & M University
         College Station, Texas 77842
      2. Vocational Agriculture Service
         343 Mumford Hall
         Urbana, IL 61801

Curriculum Validation Statement

1. A research study of Oregon manpower needs in agriculture was conducted to determine agricultural job titles which have potential for placement of high school graduates in Oregon.
2. McClays study on competencies needed by persons employed within various agricultural occupational titles was used to assess the coverage of the technical agricultural competencies contained in the curriculum guide.
3. All job titles and competencies were covered over the course of the four-year curriculum guide and thus the curriculum package (Ag I, Ag II, Ag III and Ag IV) was considered valid for use in Oregon.
4. A group of sixteen (16) Oregon Vocational Agriculture teachers formed the curriculum project advisory committee and provided guidance for scope and sequence of the materials. They also provided input for the format of the curriculum guide.

   It was the feeling of the project staff that the best source of information for curriculum content and format for vocational agriculture teachers in Oregon were the vocational agriculture teachers themselves. The names of the advisory committee members were listed in the Preface of the introduction.

The Four Year Unit Outline:

The four year unit outline which was developed by the curriculum Advisory Committee as a guide for vocational agriculture instruction in Oregon follows. This guide was developed and validated using the manpower data discussed in section F of the Introduction.

Ag III - a - 44

# CURRICULUM
for
Vocational Agriculture

SCHOOL YEAR ____________ DEPARTMENT ____________

TEACHER'S NAME Oregon Vo-Ag Curriculum

Week		Special Events	FIRST YEAR—(1st and 2nd Semesters)	SECOND YEAR—(3rd and 4th Semesters)
Number	Date		Name of Course Ag I	Name of Course Ag II
1			-Intro. Vo-Ag Prog., SOEP, FFA	-Intro. & Records Update
2			-Tractor Operation & Safety	-Fencing (2 wks.)
3			(4 wks)	-Fencing
4	Fri.	Check Record Books (except Frosh)		-Soils (5 wks.)
5			↓	Morphology, Drainage
6			-FFA: History, Org., Programs	Testing
7			(3 Wks) Creed	Fertilizers
8	Fri.	Check Record Books (except Frosh)		Evaluation (Judging)
9			-Small Engines: Prev. Maint. and Winterization	Animal Nutrition (4 wks)
10			-Intro. to Beef: Breeds, Parts,	" "
11			Term, Selection, Thumb Rules Mgmt	Ration Formulation
12	Fri.	Check Record Books (except Frosh)	-SOEP: Decision Making - Select	" "
13			Project, Begin Record Book	Public Speaking (2 wks)
14			-Parliamentary Procedure	" "
15			(3 Wks)	Record Books (2 wks)
16	Fri.	Check Record Books	↓	" "
17			-Christmas Vacation X X X X X X X	X X X X X X X X X X X X X X X X
18			-Intro. to Sheep: Breeds ID, Parts	-Parliamentary Procedure (2 Wks)
19			Term., Selection, Thumb Rules(1½ wks)	" "
20			-Local Adaption-Animal	-Advanced Ferrous Welding (5 Wks)
21	Fri.	Check Record Books	Science (2½ Wks)	
22			-Intro. to Swine: Breeds, Parts	Arc (vertical & horizontal)
23			Term., Slec., Thumb Rules (1½ Wks)	O-A (braze, weld & cut)
24			-Shop: Safety, Skills Demo., Tool	" "
25	Fri.	Check Record Books	ID. & Basic Plans Reading	Preventive Maintenance (3 wks)
26			Intro to: Arc } 2 wks	
27			O-A }	
28			-Spring Vacation X X X X X X X X	X X X X X X X X X X X X X X X X
29			Wood Project } 2 wks	-Plant Sci: Local Adaptation
30			}	(4-5 wks) Crops (Forages & Cereal)
31			Tape & Die }	or
32			Tool Fitting } 2 wks	Horticulture
33			-Plant Sci: Local adaptation	" "
34	Fri.	Check Record Books	Crops &/or Hort.	Livestock Skills (4-5 wks)
35			(4 Wks)	" "
36			↓	" "
37			-Showing & Fitting: Beef	Appendix - Livestock Selection
38	Fri.	Check Record Books	Sheep, Swine - Close school	Appendix - Horses & Horsemanship

KEY

☐ Animal Science
☐ Soil Science
☐ Plant Science
☐ Agricultural Mechanics
☐ Agriculture Business Management
☐ Leadership and Personal Development

Number	Date	THIRD YEAR–(5th and 6th Semesters) Name of Course Ag III	FOURTH YEAR–(7th and 8th Semesters) Name of Course Ag IV
1		-Intro. & Records Update	-Intro. & Records Update
2		-Land Measurement & (2 Wks)	-Irrigation Systems (2 Wks)
3		Surveying	" "
4	Fri.	-Animal Production (6 Wks)	-Production Records (2 Wks)
5		Genetics, Breeding Programs,	" "
6		A.I., Record Keeping Systems	-Projects (6 Wks)
7		Health,	"
8	Fri.	Sanitation & Diseases	"
9		(symptoms, prevention, cure)	"
10		-Electric Wiring (2 Wks)	"
11		" "	"
12	Fri.	Electric Motor Maintenance (2 Wks)	-Farmstead Layout (3 Wks)
13		" " "	Lighting, storage, corral
14		Plumbing (1 Wk)	systems, & ventilation
15		-Informative Speaking	-Persuasive Speaking
16	Fri.	-Record Books	-Record Books
17		X X X X X X X X X X X X X X X X X X	X X X X X X X X X X X X X X X X X X
18		-Applications(St.Farmer, Profic.,	-Farm Taxes (2 Wks)
19		-Non-Ferrous & Repair Welding(4 Wk)	" "
20		Metal Identification	-Ag Financing, Farm Law, (4 Wks)
21	Fri.	Aluminum, Cast Iron,	Ag Agencies and
22		Hardsurfacing, High Carbon Steel	Machinery Management
23		-Preventive Maintenance (3 Wks)	" "
24		Tractors & Machinery	-Agricultural Cooperatives, (4 Wks)
25	Fri.	Hydraulic Systems	Agricultural Marketing
26		-Meats (2 Wks)	(Futures, Contracts,
27		"	Open market, etc.)
28		X X X X X X X X X X X X X X X X X X	X X X X X X X X X X X X X X X X X X
29		-Plant Science: Local adaptation	-Pesticides (3 Wks)
30		(5 Wks) Specialty crops or	safety, applicator license,
31		Farm Forestry or,	equipment calibration
32		Horticulture or,	-Building Construction (7 Wks)
33		Christmas Tree Production	concrete
34	Fri.	-Harvesting Equipment (5 Wks)	building materials
35		Combines,	building nomenclature
36		Balers-Swathers,	build a small structure
37		Forage Harvestors,	" " "
38	Fri.	Specialty Equipment	" " "
		Appendix - Bees	

*Note: Career information is to be inserted in each unit as it is covered - there is no separate career unit.

TEACHERS USE GUIDE

1. This unit is designed to help you orient students to the program during the first week of class.
2. Included is:
    a. Unit Calendar
    b. Objectives
    c. Outline
    d. Vo-Ag Department Policies
    e. Notebook Requirements
    f. SOEP Question and Answer Sheets
    g. SOEP Policy Sheet
    h. FFA Information Sheet
    i. Discipline Sheet
    j. Example Calendar of Activities
3. You should in the process of teaching this unit hand out a, d, e, f, g, h, and j.
4. f, g, and h, can be used in your summer recruitment effort and also given to parents.
5. The calendar of activities should be completed prior to school by you and the FFA executive committee.

Agriculture III Curriculum Units

I - Introduction and Records Update

II - Land Measurement and Surveying

III - Animal Production
    A. Animal Reproduction
    B. Livestock and Poultry Diseases

IV - Electric Wiring and Electric Motor Maintenance

V - Plumbing

VI - Informative Speaking

VII - Record Books

VIII - Applications (State Farmer, Proficiency)

IX - Non-Ferrous and Repair Welding

X - Preventive Maintenance

XI - Meats

XII - Berry Production

XIII - Grass Seed Production

XIV - Nursery Production

XV - Landscape Design

XVI - Christmas Tree Production

XVII - Range

XVIII - Harvest Equipment

XIX - Bees

XX - Chainsaws

INTRODUCTION TO VOCATIONAL AGRICULTURE

OBJECTIVES:

At the completion of this unit the student will:

1. Know what they will learn if they stay in Vo-Ag for 4 years.
2. Understand that SOEP is a requirement and a major part of the program.
3. Take information home pertinent to the Vo-Ag program.
4. Purchase a notebook and keep all information from Vo-Ag class in it.
5. Know and understand the classroom rules and school policies.
6. Understand the grading system.
7. Know why FFA participation is a part of the program and why it is important.
8. Understand the total program concept of SOEP-Classroom-FFA.

OUTLINE

I. School Policies
  a. Student Handbook

II. Introduction to Vo-Ag
  a. 4 year curriculum and unit calendar
  b. What to expect

III. Notebook Requirements
  a. Distribute Handout
  b. Discussion

IV. Student Control Plan
  a. Handout
  b. State a few of your own rules
  c. Allow students to help you set the rest of the rules.

V. Grading
  a. Classwork
  b. SOEP grade

VI. SOEP Requirement
  a. Discuss Handout
  b. Take handout home to parents

VII. FFA
  a. Discuss Handout
  b. Discuss Calendar of Activities
  c. Take home to parents

VIII. Total Program Concept
  a. FFA-SOEP-CLASSROOM
  b. Explain how each fits into the program
  c. Discuss handout

VOCATIONAL AGRICULTURE DEPARTMENT

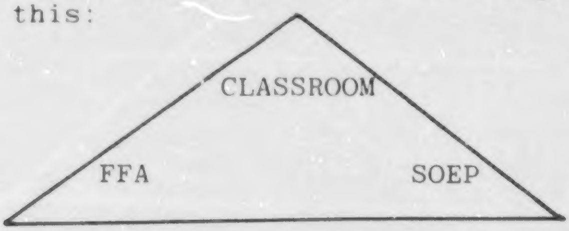
What is Agriculture?

To many people, agriculture is thought to be the production of plants and animals to provide the food and fiber for the people of the world. However, agriculture is more than that. Agriculture includes all occupations where knowledge, skills, and abilities are necessary for a person to enter into an agricultural occupation. Agriculture includes farmers, ranchers, buyers and sellers of agricultural products, agricultural mechanics, cowboys, inspectors, salespersons, chemists, teachers, scientists, economists, and many other occupations. The total picture of agriculture includes the pure and applied science necessary to get the raw materials onto the supper table.

What is Vocational Agriculture?

Vocational Agriculture is an elective subject, offered to students who want to work in some phase of agriculture. Vocational agriculture is designed to help prepare students to enter into an agricultural occupation and/or go on to further their education at a junior college or at an agricultural college.

Vocational Agriculture is made up of three main parts that are taught and used each year. Vocational agriculture can be pictured like this:



In order for our vocational agriculture classes to truly be successful we must have all three of the above state components. Classroom instruction gives the students the knowledge and background information needed to begin working. SOEP gives the students the "hands-on" experience and builds the skills necessary to gain employment. FFA allows opportunity to apply skills in a fun way. It also allows opportunity to gain recognition for your efforts. FFA-SOEP-Classroom = Total Vocational Agriculture Program. These three parts form a triangle. With one part missing, the triangle falls apart. All students must be involved in the three parts for the program to be a success.

The first two years will be mainly agricultural science, agricultural mechanics, SOEP, and leadership development through FFA.

The last two years of Vo-Ag will be directed toward the application and specialization of the principles learned in the first two years. The student may choose to specialize in Agricultural Production and Management, or Ag. Mechanics.

The Agricultural Mechanics program places major emphasis upon project design, fabrication and utilization, selection, maintenance and repair of internal combustion engines, field machinery, management irrigation and water management, agricultural structures and environmental control.

The Agricultural Production and Management program places major emphasis upon the development of management competencies in the areas of plant science, animal science, soil science, ag business management and ag mechanics as related to the multiple facets required for the production of feed and fiber.

What about the FFA?

The Future Farmers of America, or FFA as it is commonly called, is an integral part of vocational agriculture. Through the activities of the FFA the in-class instruction can become more meaningful and useful to the students. Therefore, it is strongly urged that all students taking Vocational Agriculture join and participate in the various activities of the FFA.

The FFA is a national organization made up of students enrolled in Vocational Agriculture and strives to develop agricultural leadership, cooperation, and citizenship in its members.

What are the requirements to enroll in Vocational Agriculture?

1. Students must have and express an interest in a career in some phase of agriculture.

2. All students taking Vocational Agriculture will be required to have an occupational experience program in agriculture to make practical application of the class instruction. An occupational experience program can provide additional opportunity to develop responsibility, help establish goals, and set values and ideas for young people. The program will be periodically supervised by the Vocational Agriculture teacher. Examples of good SOEP's are work experience in agriculture, livestock projects, crops projects and home improvement projects.

3. Each student must keep and maintain accurate records on his/her own supervised occupational experience program or project.

4. Each student will obtain a social security card.

5. All students are strongly urged to join and become a part of the FFA. The FFA will be used in the classroom to interest and involve students. Those

who are not members will feel that they are missing something when their fellow students wear the blue and gold jackets, attend the meetings, contests and field days.

6. Students must furnish their own materials for projects that are constructed for their own use or exhibits at fairs.

REQUIREMENTS FOR AGRICULTURE CLASS NOTEBOOKS

I. Each student will keep a class notebook which is comprehensive, current, and organized in the manner to be described below.

A. A good notebook serves several purposes:
1. Record of student's performance in class.
2. Reference source at some later date.
3. Study materials for class tests.

II. ORGANIZATION

A. Each student will have their Agriculture notebook, (looseleaf), divided into six sections with each section divider marked in an easily noticeable fashion.

1. Each notebook shall have the following six sections in this order:
   a. Animal Science
   b. Plant Science
   c. SOEP
   d. FFA
   e. Ag. Mechanics
   f. Tests and other assignments

B. Each divider will be properly indexed and all materials will be kept in chronilogical order. Pages will be numbered and units will be listed on the front of each divider.

III. STANDARDS REQUIRED OF EACH STUDENT

A. Notebooks will be evaluated twice each semester. The evaluation will be worth 50 points and will be based on completeness, organization, content, and neatness.

B. A grade sheet will be placed in front of your notebook. This sheet will be used by the instructor for recording your notebook grade and comments on the notebook.

C. Deficiencies noted by the instructor should be corrected as quickly as possible. These items will be checked again the next grade period.

D. You are held responsible for the class notes on the days you are absent irregardless of the excuse. It is your personal responsibility to see that any deficiencies caused by absences are made up.

E. You will need to bring a pen or pencil with you every day to class. Special note paper may be made available to you for class work.

SUPERVISED OCCUPATIONAL EXPERIENCE PROGRAM (SOEP) QUESTION AND ANSWER SHEET

1. WHAT IS THE SUPERVISED OCCUPATIONAL EXPERIENCE PROGRAM?

   The SOEP is an out of class project dealing with agriculture. It is a part of Vocational Agriculture curriculum across the United States.

2. WHAT IS THE PURPOSE OF THE SOEP?

   The purpose of the SOEP is to provide actual training and career experiences in agriculture, for students.

3. WHO NEEDS TO HAVE A SOEP?

   Every Vocational Agriculture student must have a SOEP. It is a part of the agriculture class.

4. WHAT TYPES OF SOEP ARE THERE?

   There are 4 types of SOEP available:
   a. Supervised Farming Programs
   b. Cooperative Work Experience
   c. Home Improvement
   d. Supervised Laboratory

5. WHAT ARE SOME SPECIFIC SOEP POSSIBILITIES?

   There are many SOEP possibilities. Listed below are a few.
   a. Raising a market animal: Beef, Sheep, Swine, etc.
   b. Raising a breeding animal.
   c. Planting a vegetable garden and selling the produce.
   d. Growing a grain crop.
   e. Working for a local farmer, nursery owner, etc.

6. BY WHAT DATE MUST THE SOEP BE STARTED?

   All agriculture students must have a working SOEP by January 10. Students will work on SOEP plans in class early in the school year.

7. HOW WILL THE VOCATIONAL AGRICULTURE TEACHER SUPERVISE THE SOEP'S?

   The vocational agriculture teacher will visit each student's SOEP during the school year for the purpose of supervision and grading.

8. HOW WILL THE SOEP AFFECT VOCATIONAL AGRICULTURE CLASS GRADING?

   The SOEP is worth 100 points per grading period. (Approximately two test scores). Any student without an SOEP by January 10 cannot receive better than a "C" grade for the last two grading periods.

9. WHAT MAKES UP THE SOEP GRADE?

SOEP grading is based on two things:
a. The student's SOEP record book.
b. The instructor's visits.

Each student will be given a book in which to keep records on his/her project. A complete and neatly kept record book will receive maximum points.

On the SOEP visit the instructor will look for project management - whether the student is the primary person responsible for the SOEP, how well it is cared for, etc.

** NOTE: Projects should be of a type that relates to an agricultural career which the student might someday like to enter.

SUPERVISED OCCUPATIONAL EXPERIENCE PROGRAM POLICY - VOCATIONAL AGRICULTURE DEPARTMENT

I. INTRODUCTION

Due to the many first hand learning experiences each participant receives in planning, budgeting, feeding, managing, raising crops, construction, exhibiting, record keeping, etc,. the supervised project program is an essential part of the Vocational Agriculture Program.

II. Policy Statement

A. Each student enrolled in Vocational Agriculture will have a SOEP.

B. The project should be tailored to fit each student's particular home situation, desires and goals.

C. The student's project is used as a basis for many FFA awards.

D. All students should have some home improvement project.

E. Production project, cooperative work experience and supervised laboratory projects are also encouraged.

F. Periodically during the school year the instructor will check each students project record book to evaluate his/her record keeping skills.

G. Evaluation will be on the following aspects:
   1. Individual performance (progress)
   2. Record keeping skills
   3. Attitude towards the project
   4. Type of project
   5. Applicability to occupational goals

H. A long range plan will be completed by the student with the help of the vocational agriculture instructor and their parents.

I. Periodically during the school year and summer, the instructor will make project visits to the student's home to familiarize himself/herself with each project, progress, planning and to provide assistance.

J. Understandably, satisfactorily meeting the above standards for supervised projects places a big responsibility upon each student in Vocational Agriculture. However, with a positive attitude, parental support, teacher and older student assistance, we seek each student's full cooperation in this important aspect of their Vocational Agriculture training.

The largest national student organization in America, made of, by, and for students in agriculture... A chance for you to belong to a group of people who share and actively pursue their interests in the world of agriculture... An opportunity to increase the value of your vocational agriculture program at school by getting involved in agriculture outside the classroom...

That's F.F.A.

THE FUTURE FARMERS OF AMERICA!!!

F.F.A. serves a purpose--

F.F.A. activities balance classroom instruction with applied practical programs, laboratory experiences, and group projects. There is help for the directing of individual projects or lab opportunities in the agriculture/ agribusiness fields through S.O.E.P. (Supervised Occupational Experience Projects) where you take charge of your choice guided by your Vo-Ag instructor and F.F.A. leaders and assisted whenever the need arises.

Activities in your F.F.A.

--Field Trips to agricultural areas of interest:

Greenhouses, Feed Lots, Machinery Dealerships, Animal Hospitals

Where would you like to go??

--Contests that give you the chance to learn the best methods of feeding and caring for show animals or for raising crops to show at county fairs, state and even national championships. Compete with other F.F.A. Chapters and states in public speaking, crop & livestock evaluation and mechanics.

--Leadership and self confidence are natural outgrowths of participation in F.F.A. Members learn how to express themselves and organize their group using the same parlimentary procedure that our Congress uses. If leading your group sounds exciting there are lots of opportunities to polish your skills and even contests to compete in to show them off.

--Earn Money and Awards with your chapter or on your own. That S.O.E.P. steer you raise may earn you more than a ribbon at the fair. (He's worth a lot of money too!) There are awards for team projects or for individual ones... Ribbons, pins, plaques, trophies and purses are presented by the F.F.A. to winning projects and to successful individuals.

--Travel with team members to district, regional, state, and national contests and conventions. These are exiting opportunities to see new places and meet people. You can really go places in F.F.A.!!!

--Community Service is a rewarding part of F.F.A. Find out how much you have to offer.

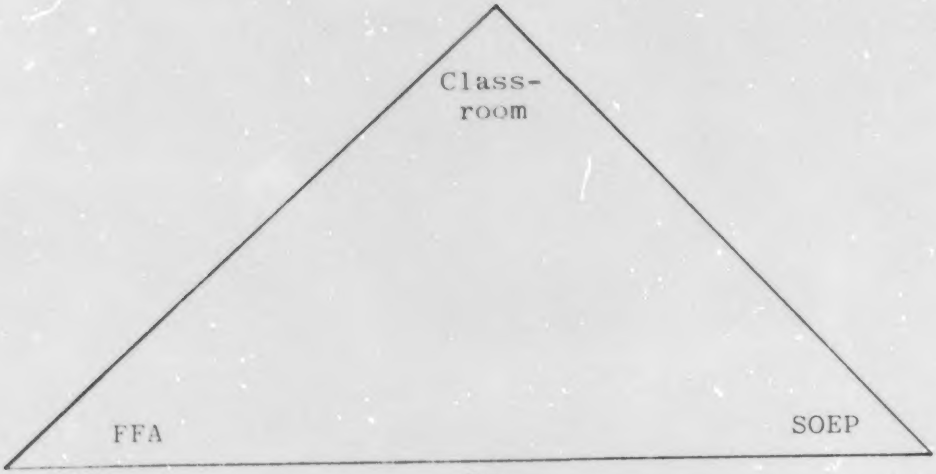
--Recreation is a big part of F.F.A. Picnics, Games, Hayrides, Dances... It's up to you what you decide to do. The list of recreations is only limited by your imagination.

What would you like to do??

It's to your advantage to be a part of today's F.F.A.--

As a student, your future in agriculture depends on your experiences today. In the F.F.A. you will be among people who have related goals and educational interests. The more exposure you have to agriculture today the better you will be able to find a satisfying place in the field of agriculture tomorrow. It's always more fun to become involved in your field in the company of others who share your interests. Get involved now. You'll always be glad you did!!

Relationship of FFA to Agriculture/ Agribusiness Education



Discipline and Management Suggestions

Classroom control is a prerequisite to classroom learning and many times the key to control and discipline is good classroom organization and management. Achievement is greatly increased for students who are provided with learning experiences in a well disciplined and well organized atmosphere. Those who are not disciplined waste their own individual opportunities and make learning difficult for others. Positive discipline and classroom control and management can only result through joint effort upon the part of the teacher and student.

Organization

- Set classroom climate by how students enter and leave the classroom.
- Begin class promptly and with real enthusiasm. Use an attention getter or interest approach to motivate them.
- Have a routine in all classroom procedures to give security and establish precedents and policies.

Policies and Standards

- Let student help set policies.
- Keep rules short and simple and adhere to them.
- Develop room standards of behavior.
- Carefully observe all rules expected of the class.
- Use lesson plans that will not be upset by restlessness at such times as before vacation.
- Make assignments clear.
- Be sure class members understand what they are to do. Check to see that directions are really clear.
- Hold every member of the class responsible for knowledge of each concept.
- Grade in terms of assignments

Personal Qualities

- Learn students' names quickly
- Be friendly, smile and greet students by name.
- Develop a sense of humor which is the ability to have real fun and to laugh at anything truly humorous.

- Let students know you are capable of laughing with them and at yourself.

- Use your voice to advantage by keeping it rich and calm and never speak over a noisy situation.

- Keep your voice audible but quiet, firm and low-pitched.

- Be impartial and fair. Do not play favorites or hold grudges.

Physical Atmosphere

- See to it that ventilation and air circulation and lighting are good.

- Strive to keep the room pleasant and attractive.

- Use student activity, discussion and exhibits to create interest.

- Keep classroom orderly by sharing housekeeping responsibilities with students.

- Have supplies and equipment conviently located.

- Have a place for everything and insist that items be kept in the proper place.

Classroom Management

- Keep students by providing a full period of work.

- Be prepared; have alternate plans. Plan so students will have enough work all period, yet not frustrated by undue pressure.

- See that the class is busy before meeting the needs of the few.

- Know what each student is doing at all times.

- Divide large classes into smaller work and study groups.

- Avoid interruptions when students are working on a project.

Know Your Students

- Discover student interests and special activities.

- Spread responsibility and give each a chance to gain recognition in a positive way.

- Try to find the strong points of the behavior problem child. Help him/her to achieve.
- Gear teaching experiences to the interests and abilities of the students in class.
- Accept behavior for what it is and what it is trying to achieve. Try to fill the student's need another way so that a child will not have to use unacceptable behavior to gain his/her ends.
- Know your parents and the community.
- Study the seating of students carefully with an eye to possible necessary changes.
- Note acceptance of individuals by classmates.

Discipline Ideas

- Be confident. Do not ignore small things. Be aware of them, and, if possible, correct offenders with quiet signals.
- Reprimand in private and not in front of the class.
- Try to handle your own classroom discipline before asking administrative assistance.
- Be consistent!
- Do not let discipline problems drag out. See what needs to be done and take the necessary action.
- Act after thinking through the consequences rather than threaten things that cannot be carried out.
- Be self-controlled.
- Do not argue! Discuss but do not over-discuss.
- Do not create situations which encourage students to challenge your authority.
- Do not threaten and make "deals" to gain control.
- Listen to the student's side of any troublesome situation.
- Use common sense, have confidence in yourself and trust your judgment.

In Summary

- Look at your own self in regard to:
    - Self-confidence
    - Voice
    - Enthusiasm
    - Sense of humor
    - Personal appearance
    - Fairness
    - Optimism
    - Promptness
    - Manners
    - Attitude
    - Understanding
    - Values

- Remember that behavior is caused, so work on the causes as well as the behavior.

- Work with parents and community and not by yourself.

- Do not expect change all at once as change takes time.

- Constantly re-evaluate your classroom techniques and look for new methods.

- Do your best! No one asks more!

EXAMPLE FFA CHAPTER'S CALENDAR OF ACTIVITIES

SEPTEMBER

- Concession Stand
- FFA Meeting
- District Advisors Meeting
- County Fair
- Freshman Meeting
- FFA Creed Speaking Contest
- District Meeting
- State Officers Leadership Tour

OCTOBER

- Dues Deadline
- FFA Parent Potluck
- Concession Stand
- FFA Meeting
- P.I.L.E. Portland
- District Soils Judging Contest

NOVEMBER

- National FFA Convention - Kansas City, Missouri
- FFA Meeting
- Hay Ride
- District Advisors Meeting

DECEMBER

- FFA Meeting
- District Advisors Meeting
- Snow Party

JANUARY

- State Farmer Applications Deadline
- State Farmer Formal Interviews
- FFA Meeting
- District Advisors Meeting
- Chapter Public Speaking Contest

FEBRUARY

- Chapter Proficiency Award Contest
- FFA Meeting
- National Chapter Applications Deadline
- District Leadership Skills Contests
- National FFA Week
- District Proficiency Awards Contest
- Sectional Leadership Skills Contest

MARCH

- Chapter Officer Interviews
- District FFA Meeting
- District Officer Elections
- Chapter Book and Record Book Contest
- COOP Quiz Contest
- FFA Meeting
- State FFA Convention
- Slave Sale

APRIL

- FFA Meeting
- FFA Parent/Member Banquet
- Officer Installation
- Tractor Driving Test
- Shop Skills Contest

MAY

- FFA Meeting
- District FFA Meeting
- Livestock Judging
- Swimming Party
- Graduation

JUNE

- Livestock Shows
- FFA Meeting
- School's Out

JULY

- FFA Meeting

AUGUST

- County Fairs
- Livestock Judging Contests
- State Fair
- Leadership Camp
- State Tractor Driving Contest
- Ag Teachers Picnic

RECORDS UPDATE

Instructor's Guide

1. This unit is designed to assist students in bringing their record books up to date and establish on-going procedures for keeping the record books current throughout the year.

2. Have students review the records unit found in the Ag I curriculum. The unit in Ag I was designed for freshman, sophomores, juniors, and seniors. Students should review the unit according to their levels of individual need.

3. Use those parts of the unit that are needed to build upon recordkeeping skills learned in their freshman year. Have students bring their recordkeeping books up to date.

4. The records unit from Ag I is available in Arizona.

5. Students should become involved in a records update early in the school year, followed by periodic updates throughout the remainder of their program.

6. During this records update, the instructor should establish expectations, procedures, and schedules for keeping record books up to date throughout the remainder of the year.

OBJECTIVES

1. Bring record books up to date.

TEACHING AIDS

1. Student record books.

2. Notes, receipts, billing statements, and other materials needed for making entries into project record books.

STUDENT ACTIVITIES

1. Review records unit from Ag I curriculum.

2. Bring entries up to date.

3. Have instructor check record book for accuracy and completeness.

4. Revise record book according to recommendations of the instructor.

REFERENCES

1. Records unit - Vo-Ag I Curriculum Guide. Oregon State University.
2. Guide for Using the Vocational Agriculture Record Book for Production Agriculture. French-Bray. Baltimore, Maryland.
3. Vocational Agriculture Record Book for Production Agriculture. French-Bray, Baltimore, Maryland.

Land Measurement And Surveying

Introduction:

This unit contains more than the basic information needed in agricultural land measurement and surveying. It is subdivided by topic therefore an instructor may easily select that which is of most value to their program.

Objectives:

Upon completion of this unit, the student will be able to:

1. Read and write land descriptions.
2. Use agricultural leveling and land measuring equipment.
3. Understand leveling operations.

Instructor Activities:

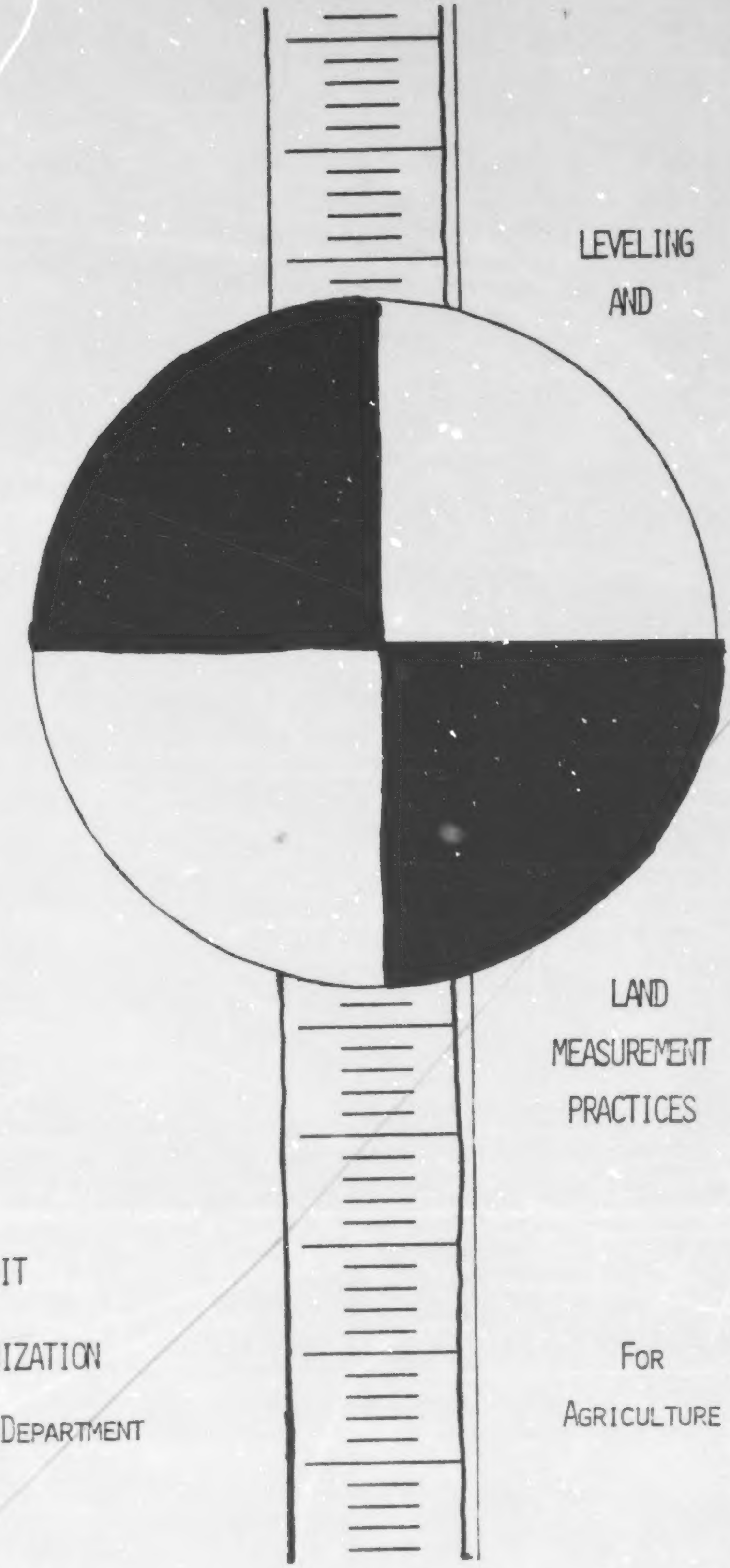
1. Duplicate instructional materials for students.
2. Set-up surveying, land measurement, and land leveling excercises.

Student Activities:

1. Participate in discussions and complete reading.
2. Participate in lab exercises.

Ag III - II - 2

LEVELING
AND
LAND
MEASUREMENT
PRACTICES
FOR
AGRICULTURE



A REFERENCE UNIT
IN
AGRICULTURAL MECHANIZATION

AGRICULTURAL EDUCATION DEPARTMENT

TABLE OF CONTENTS

Unit Page

Table of Contents . . . .

I. LEGAL LAND DESCRIPTION. . . . .

II. AGRICULTURAL LEVELING AND LAND MEASUREMENT EQUIPMENT . . . .

- Leveling Equipment . . . .
- Land Measurement Equipment . . . .
- Determining Land Acreage . . . .

III. USING LEVELING AND LAND MEASURING EQUIPMENT . . . .

- The Tripod Level . . . .
- The Leveling Rod . . . .
- Field Signals. . . . .
- Leveling Terms and Field Notes . . . . . .
- The Steel Tape . . . .
- Measuring Horizontal Distances With a Level . . . .
- Land Measurement by Use of Aerial Maps. . . . .

IV. LEVELING OPERATIONS. . . . .

- Differential Leveling. . . . .
- Profile Leveling . . . .
- Contour Mapping. . . . .
- Grades, Cuts, and Fills. . . . .

APPENDICES

- A. Laying a Foundation. . . . .
- B. Field Note Page. . . . .
- C. The Hand Level . . . .
- D. Useful Numbers in Leveling . . . . . .
- E. Staking Out a Fence. . . . .

UNIT I

LEGAL LAND DESCRIPTION

Introduction:

The oldest historical records in existence today, which bear directly on the subject of surveying and land measurement, state that this science had its beginning in Egypt. In about 1400 B.C., the land of Egypt was divided into plots for the purpose of taxation. When annual floods of the Nile River swept away portions of the plots, surveyors were appointed to reidentify land boundaries. These early surveyors were called "rope stretchers". Their measurements were made by means of ropes with markers at set distances. A later innovation of measuring land distance involved the marking of a wagon wheel with a cloth and counting of the revolutions it made as it traversed a distance across the land.

The earliest land surveys were made to locate or relocate boundary lines of property. Trees and other natural objects, or stakes driven into the ground, were used to identify specific locations. As property increased in value and owners disputed rights to land, the importance of permanent monuments and written records became evident. Property titles now are transferred by written documents called deeds, which contain a legal description of property boundaries.

There are three general sources from which the description of the boundaries of real property may be found: (1) deeds, (2) official plots or (3) notes of the original surveys.

Throughout the United States, records of the transfer of land from one person to another are kept either in the office of the city or town clerk or in the county registry of deeds. Exact copies of all deeds of transfer are filed in the deed books. These files are free to be examined by anyone and are frequently a source of information to the land surveyor in trying to establish a property boundary line.

The system of description used in the United States to identify the location of land holdings for legal purposes is based upon the Rectangular System of land survey. This system dates back to the Continental Congress of 1785 which passed a law to provide for the subdivision of public lands into townships, sections and quarter sections based upon the Rectangular System.

Rectangular System of Land Survey:

The layout of the Rectangular System was accomplished in the following manner. Townships were located with reference to a true north-south line called a principal meridian and an east-west line of a true parallel of latitude called the base line. (Figure 1-1)

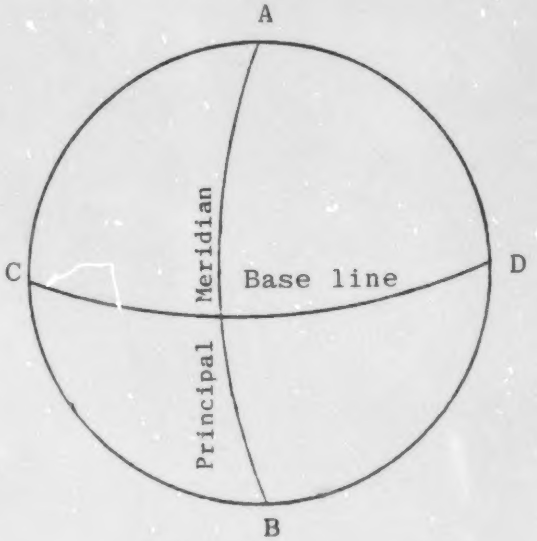


Fig. 1-1. This illustration of the earth shows the first in the Rectangular System of land survey locating the Principal Meridian (AB) and the Base Line (CD).

Where the principal meridian crosses the base line is known as the initial point.

The United States is divided into thirty-five regions for survey purposes. Each of these regions has an initial point serving as the origin for all public-land surveys.

The various initial points, base lines, and principal meridians of the United States are designated by a name assigned to the principal meridian. The name of the principal meridian for Oregon is the Willamette Meridian. (Figure 1-2)

In this text we will be mostly concerned with the Willamette Meridian which goes through the city of Portland. (Figure 1-3)

The next step in the sub-division of public lands is the placement of standard parallels and guide meridians.

Standard parallels of latitude are spaced at intervals of 24 miles north and south from the base line. The standard parallels are designated with respect to their relationship to the base line and become the First Standard Parallel North, Second Standard Parallel North, First Standard Parallel South, Second Standard Parallel South, and so forth until the limits of the regions in Oregon have been covered. (Figure 1-4)

Guide meridians are spaced at intervals of 24 miles east and west of the principal meridian. The guide meridians become known as the First Guide Meridian East, First Guide Meridian West, Second Guide Meridian East, Second Guide Meridian West, and so on depending upon their locations with respect to the principal meridian. (Figure 1-5)

Each 24 square mile tract (Figure 1-6) is divided into 16 townships by locating "range" lines (division of base lines) at 6-mile intervals and "tier" lines parallel to the latitude lines every 6 miles (Figure 1-7).

Meridians	Governing surveys (wholly or in part) in states of	Longitude of initial points west of Greenwich			Latitude of initial points		
Black Hills	South Dakota	101	03	16	43	59	44
Boise	Idaho	116	23	35	43	22	21
Chicksaw	Mississippi	89	14	47	35	01	58
Choctaw	do.	90	14	41	31	52	32
Cimarron	Oklahoma	103	00	07	36	30	05
Copper River	Alaska	145	18	13	61	49	21
Fairbanks	do.	147	38	26	64	51	50
Fifth Principal	Arkansas, Iowa, Minnesota, Missouri, North Dakota, and South Dakota	91	03	07	34	38	45
First Principal	Ohio and Indiana	84	48	11	40	59	22
Fourth Principal	Illinois	90	27	11	40	00	50
Do	Minnesota and Wisconsin	90	25	37	42	30	27
Gila and Salt River	Arizona	112	18	19	33	22	38
Humboldt	California	124	07	10	40	25	02
Huntsville	Alabama and Mississippi	86	34	16	34	59	27
Indian	Oklahoma	97	14	49	34	20	32
Louisiana	Louisiana	92	24	55	31	00	31
Michigan	Michigan and Ohio	84	21	53	42	25	28
Mount Diablo	California and Nevada	121	54	47	37	52	54
Navajo	Arizona	108	31	59	35	44	56
New Mexico Principal	Colorado and New.	106	53	12	34	15	35
Principal	Montana	111	39	33	45	47	13
Salt Lake	Utah	111	53	27	40	46	11
San Bernardino	California	116	55	17	34	07	20
Second Principal	Illinois and Indiana	86	27	21	38	28	14
Seward	Alaska	149	21	24	60	07	36
Sixth Principal	Colorado, Kansas, Nebraska, South Dakota, and Wyoming	97	22	08	40	00	07
St. Helena	Louisiana	91	09	36	30	59	56
St. Stephens	Alabama and Mississippi	88	01	20	30	59	51
Tallahassee	Florida and Alabama	84	16	38	30	26	03
Third Principal	Illinois	89	08	54	38	28	27
Uintah	Utah	109	56	06	40	25	59
Ute	Colorado	108	31	59	39	00	23
Washington	Mississippi	91	09	36	30	59	56
Willamette	Oregon and Washington	122	44	34	45	31	11
Wind River	Wyoming	108	48	49	43	00	41

Fig. 1-2. Meridians and Base Lines of U.S. Rectangular Surveys.

A series of adjacent townships running east and west is known as a tier. An adjacent series of townships running north and south is known as a range. The tiers of townships are numbered consecutively, both to the north and south of the base line. The ranges of townships are likewise numbered, both to the east and west of the principal meridian. A township is designated by the serial number of its tier and the letter N or S to indicate the position of the tier north or south of the base line; the serial number of its range and the letter E or W to indicate the position of the range east or west of the principal meridian. (Figure 1-8)

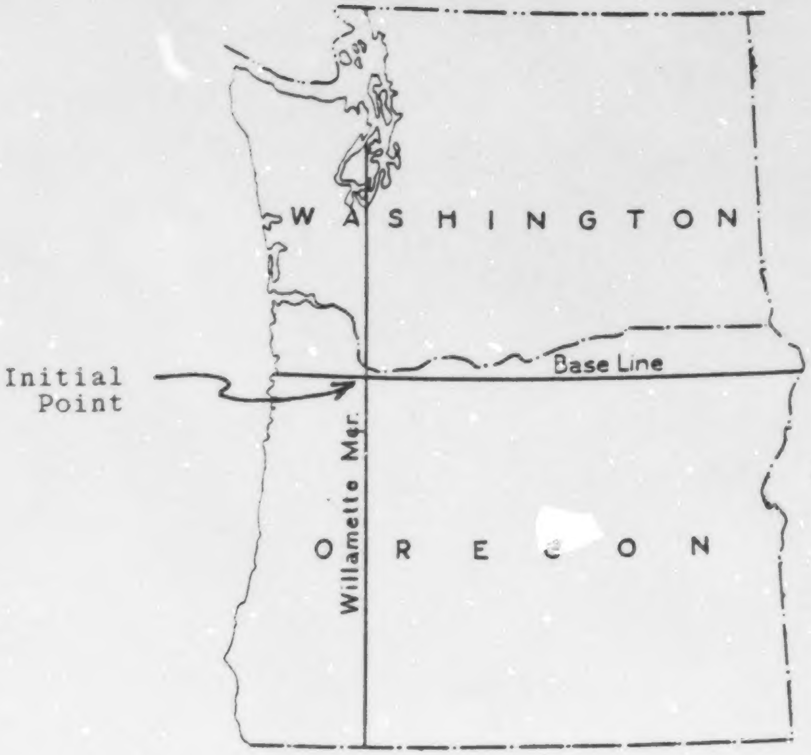

WASHINGTON
Base Line
Initial Point
Willamette Mer.
OREGON

Fig. 1-3. Initial Point and Willamette Meridian

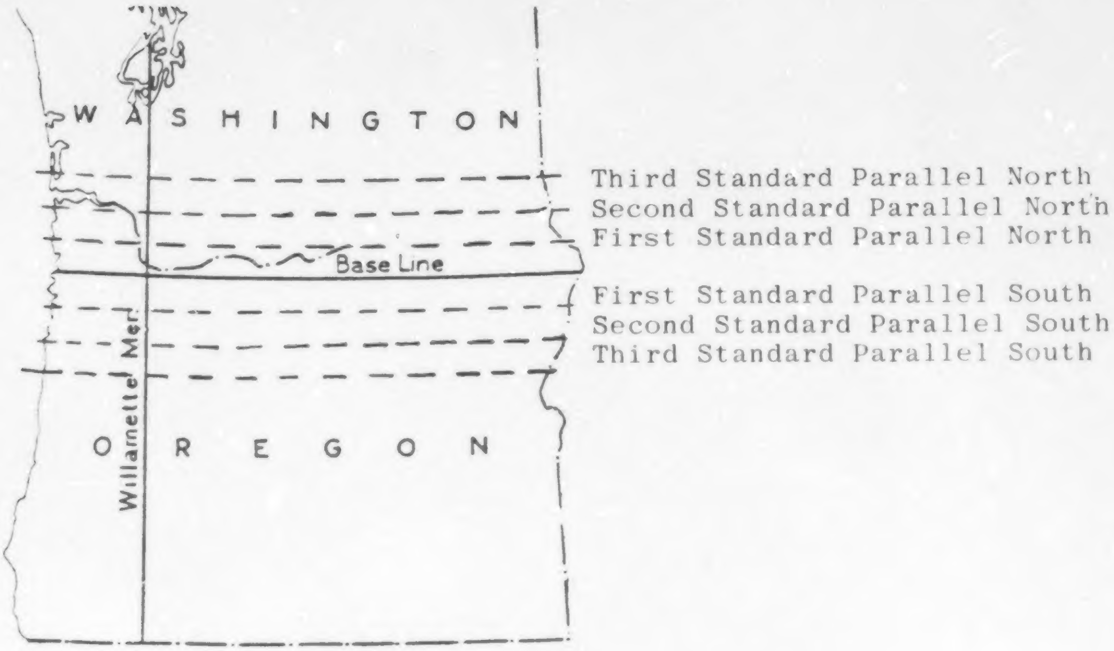

WASHINGTON
Third Standard Parallel North
Second Standard Parallel North
First Standard Parallel North
Base Line
First Standard Parallel South
Second Standard Parallel South
Third Standard Parallel South
Willamette Mer.
OREGON

Fig. 1-4. Base Line with Standard Parallels each spaced 24 miles North and South.

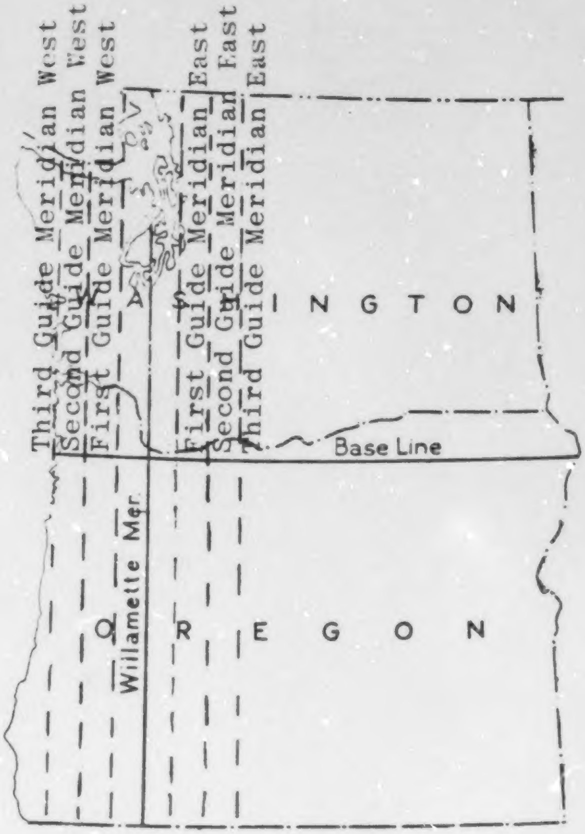

Third Guide Meridian West
Second Guide Meridian West
First Guide Meridian West
First Guide Meridian East
Second Guide Meridian East
Third Guide Meridian East
W A S H I N G T O N
Base Line
Willamette Mer.
O R E G O N

Fig. 1-5. Principal Meridian with Guide Meridians each spaced 24 miles East and West.

W A S H I N G T O N
Base Line
Willamette Mer.
O R E G O N

Fig. 1-6. This figure shows the Guide Meridians and Standard Parallels dividing the State of Oregon into 24-mile squares called tracts.

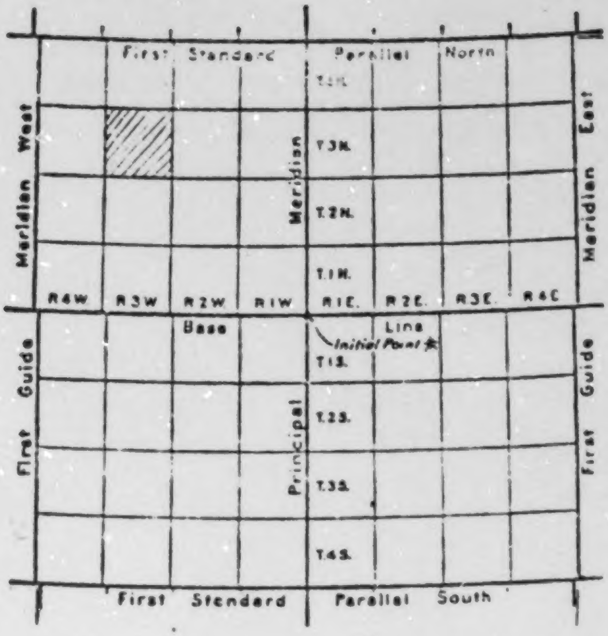

First Standard Parallel North
T4N.
T3N.
T2N.
T1N.
R4W
R3W
R2W
R1W
R1E.
R2E.
R3E.
R4E
Base Line
Initial Point
T1S.
T2S.
T3S.
T4S.
First Standard Parallel South
Meridian West
Meridian East
Principal Meridian
First Guide
First Guide

Fig. 1-7. This figure shows 4 tracts each divided into 16 townships.

▨ - Township = T3N, R3W

*Initial Point for Oregon is near the city of Portland.

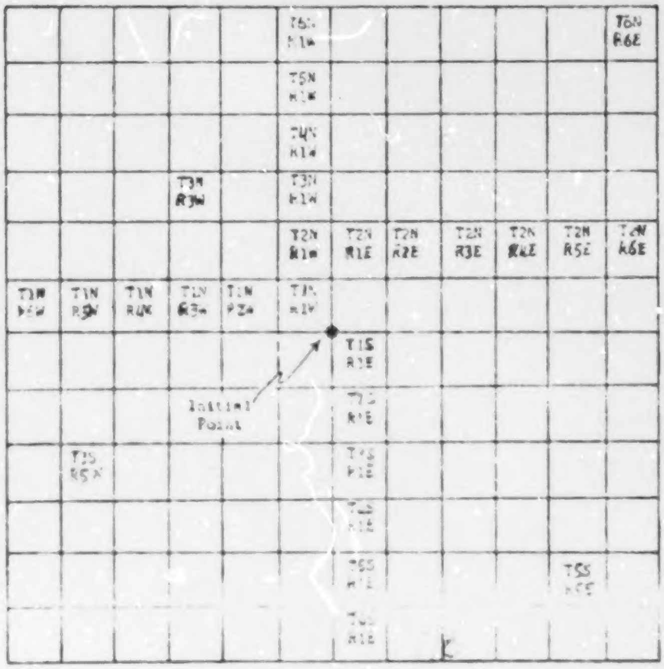
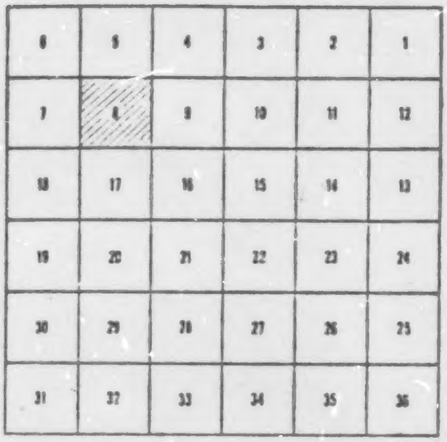

T6N R1W
T6N R6E
T5N R1W
T4N R1W
T3N R3W
T3N R1W
T2N R1W
T2N R1E
T2N R2E
T2N R3E
T2N R4E
T2N R5E
T2N R6E
T1N R6W
T1N R5W
T1N R4W
T1N R3W
T1N R2W
T1N R1W
T1S R1E
Initial Point
T2S R1E
T3S R5W
T3S R1E
T4S R1E
T5S R1E
T5S R5E
T6S R1E

Fig. 1-8. Townships are numbered consecutively from the initial point to the north, east, south and west.

Townships are further divided into one square mile sections (640 acres). The sections are numbered by starting at the northeast corner and continuing west and east across the township until the number 36 section is found in the southeast corner of the township. (Figure 1-9).



6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

▨ - Section = No. 8

Fig. 1-9. The figure shows a Township divided into 36 sections.

In review, the four major steps that have been discussed concerning the Rectangular System are:

Step I Locate initial point (where the base line intersects the principle meridian). (Figure 1-10)

Step II Locate Standard Parallels and Guide Meridians at 24-mile intervals to form tracts of land (1 tract is 24 miles square). (Figure 1-10)

Step III Divide each 24-mile tract of land into 16 equal sized Townships (1 township is 6 miles square). (Figure 1-10)

Step IV Divide each 6-mile township into 36 equal sized Sections (1 section is 1 mile square). (Figure 1-10)

The final step in the Rectangular System of Land Description is to divide up the sections and give each field or plot of land a description.

Sections can be divided into as many smaller tracts as necessary. Half or quarter sections of 320 and 160 acres, respectively, are common divisions. (Figure 1-11)

Legal descriptions always begin with the smallest unit. For example, if we wanted to describe the darkened area of the section (Figure 1-12), we would say: Northeast ¼, Section 8, Township 3 North, Range 3 West, Gila and Salt River Meridian (NE¼, S8, T3N, R3W).

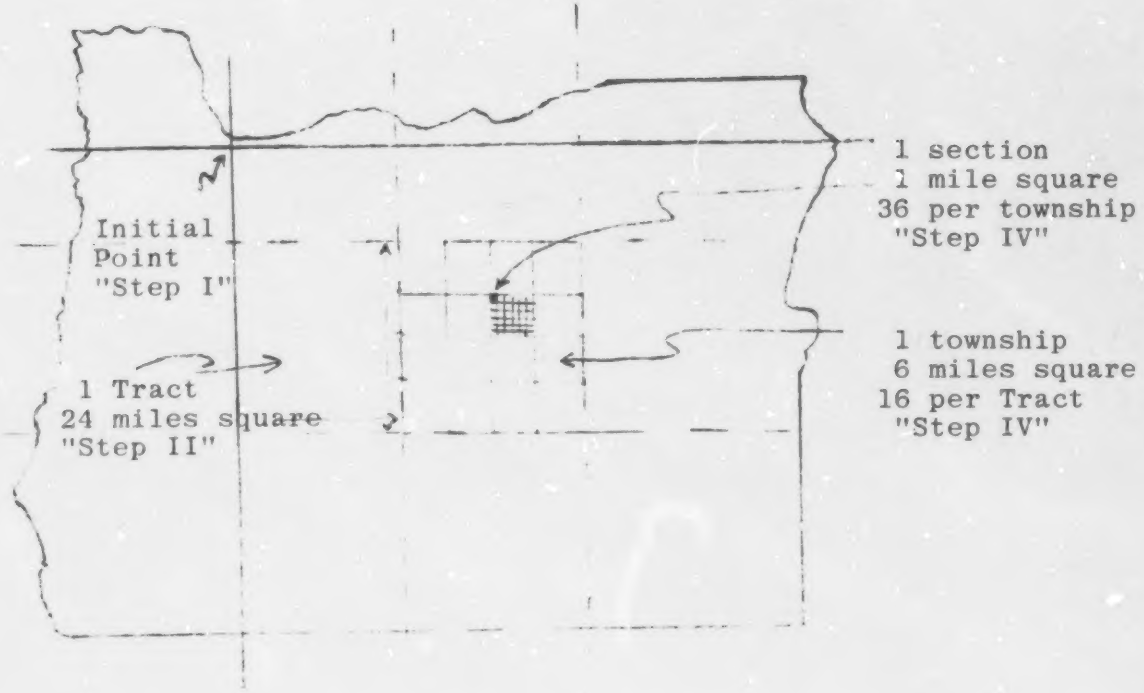

Initial
Point
"Step I"
1 Tract
24 miles square
"Step II"
1 section
1 mile square
36 per township
"Step IV"
1 township
6 miles square
16 per Tract
"Step IV"

Fig. 1-10

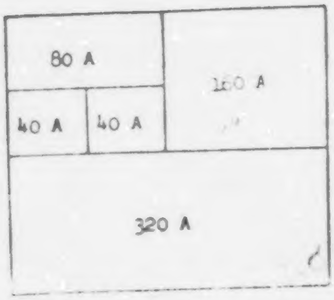
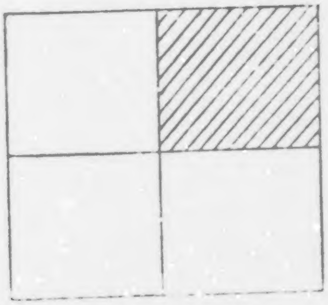
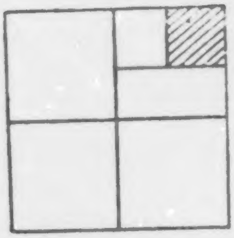

80 A
160 A
40 A
40 A
320 A

Fig. 1-11



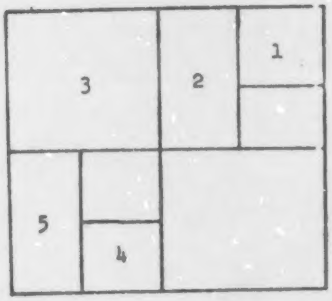
Section 8, T3N, R3W

Fig. 1-12



NE¼, NE¼, Section 8, T3N,R3W

Fig. 1-13



Section 8, T3N, R3W

Fig. 1-14

The parcel of land identified by the cross-sectioned area in Figure 1-13 would be described as: Northeast ¼, Northeast ¼, Section 8, Township 3 North, Range 3 West, Willamette Meridian (NE¼, NE¼, S8, T3N, R3N).

The legal descriptions and acreage of the parcels of land identified in Figure 1-14 are found in Table 1.

TABLE 1

Parcel	Legal Description	Acreage
1	NE¼, NE¼, Sec. 8, T3N, R3W	40
2	W½, NE¼, Sec. 8, T3N, R3W	80
3	NW¼, Sec. 8, T3N, R3W	160
4	SE¼, SW¼, Sec. 8, T3N, R3W	40
5	W½, SW¼, Sec. 8, T3N, R3W	80

UNIT II

AGRICULTURAL LEVELING AND LAND MEASUREMENT EQUIPMENT

Equipment which is used in agricultural leveling and land measurement consists of tools and materials which assist the surveyor to determine changes in land elevation and distances traversed. This equipment can be the most simple or highly sophisticated depending upon the requirements of accuracy and speed necessary to satisfy the requirements of the job.

Leveling Equipment

One of the most common operations in agricultural leveling is the determination of elevation changes in land surfaces. This operation becomes essential when slope of land or construction jobs demands data associated with a level plane. A leveling instrument known simply as a level or more specifically as the tripod level is the basic tool for measuring elevation changes in land surfaces.

Principle of Operation:

Use of a leveling instrument may be illustrated by comparing it to a carpenter's level. Imagine a carpenter's level fitted with a supporting tripod and a set of sights. If the level is held so that its bubble is in the center of the vial and a sight taken across it, the line of sight will be a level line. Every point along the level line of sight is at the same elevation. It can be used as a reference line to determine the difference in elevation of points on the ground which fall directly below the line of sight.

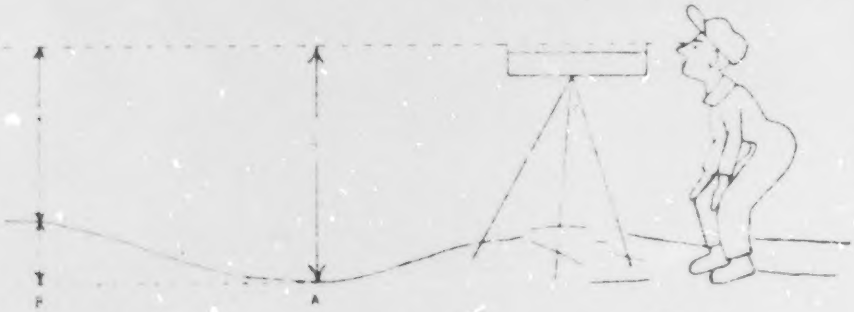


Fig. 2-1. Measuring down from the level line of sight to find the difference in elevation between two points.

In Figure 2-1, a measurement from the line of sight down to the ground at Point A shows that the elevation of the ground at that point is four feet below the line of sight. A similar measurement at Point B on the ground shows that it is three feet below the line of sight. Point A is then found to have an elevation one foot lower than Point B.

Types of Levels:

There are a number of types of levels on the market and are purchased through local hardware dealers or ordered direct from the manufacturers.

Levels range in price from $100 to approximately $1500. A farm level which costs about $100, complete with tripod, will serve excellently in surveying for land leveling and all other farm work involving the distribution of water. A surveyor's level is a more highly refined instrument and is intended for more exacting measurements than can be obtained from the lower cost instrument.

Leveling instruments of the various types are identified by the primary use for which they are intended. Generally these include the Dumpy Level (Figure 2-2), Transit (Figure 2-3), Contractor's Level (Figure 2-4), Farm Level (Figure 2-5), and Automatic Levels (Figure 2-6).

Dumpy level - The dumpy level is a rigidly constructed level in which the telescope tube, vertical supports, and horizontal bar are all made in one casting (Figure 2-2). A set of 4 leveling screws are used to level the instrument to the horizontal plane.

Dumpy levels are widely used for conducting profile and differential surveys associated with the planning and staking out erosion control, drainage and irrigation structures. The instrument is also used to lay out building foundations, and for running straight lines.

Transit - The transit and transit-level is constructed to permit the telescope tube to not only move sideways 360 degrees but in a limited vertical plane. (Figure 2-3 & 2-7)

A full transit is an instrument with a telescope tube that is able to revolve vertically a full 360 degrees. This makes it possible to take an exact opposite reading without disturbing the horizontal settings simply by rotating the tube 180 degrees in the vertical plane.

The transit and transit-level is used to lay out roads, streets, building lines, ditches, orchards, fences, hedges, fields, etc. It can also be used to establish vertical lines and planes for building walls, fences, and plumbing windows and doors.

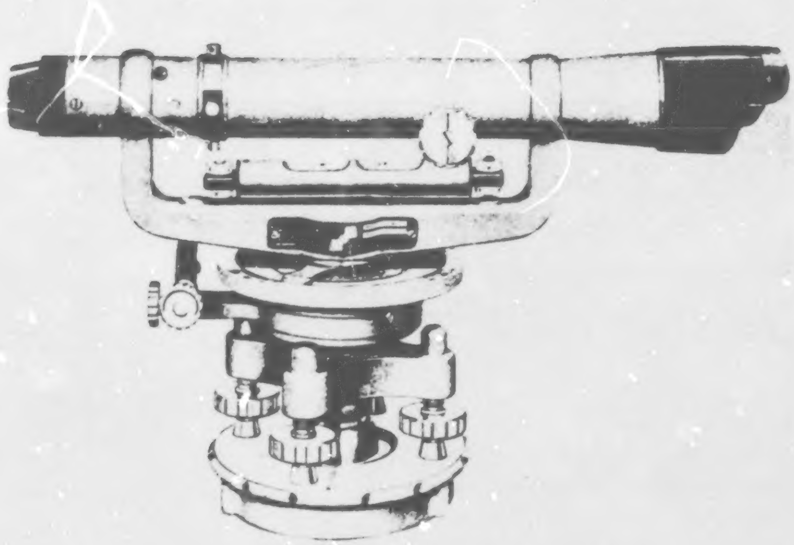


Fig. 2-2. Dumpy Level
(Courtesy of David White Instruments)

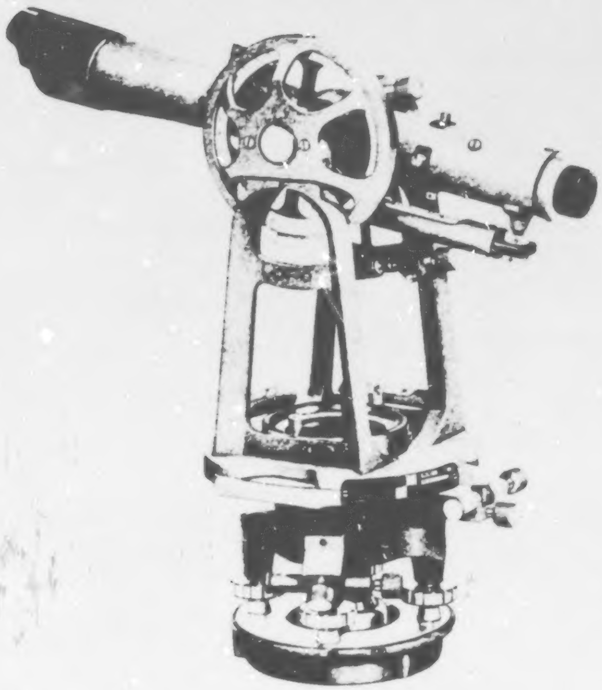


Fig. 2-3. Transit
(Courtesy of David White Instruments)

The transit level is also capable of measuring distances by calculation. In other words, if the length of one side of a three-sided triangle is known, the length of the remaining sides can be computed from the vertical angle sighted.

Contractor's level - The contractor's level employs the turret principle. The telescope and level tube are mounted in a revolving turret which can be turned over on the leveling plate to permit a quick check of the line of sight.

The contractor's level is often used to lay out a foundation, measure elevations, run straight lines, and other simple jobs. (Figure 2-4)

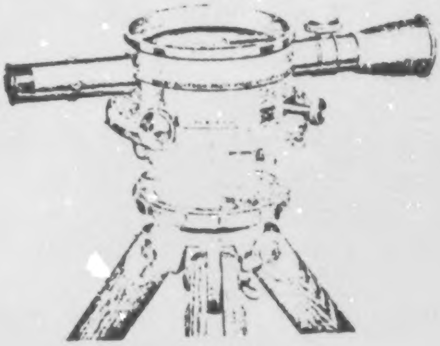
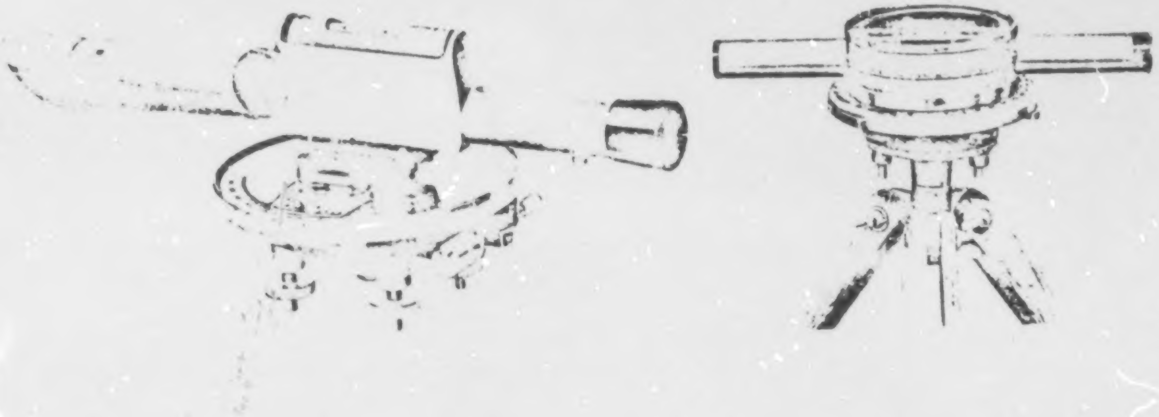


Fig. 2-4. Contractor's Level

(Courtesy of David White Instruments)

Farm level - The farm level is so called because of its use on the farm. It is designed and built for use by farmers, carpenters, builders and contractors who have need for a lightweight, dependable and inexpensive instrument. There are two common types of farm levels in use, the utility type level and the turret type level. (Figure 2-5)



Utility Type Level

Turret Type Level

Fig. 2-5. Farm Level

(Courtesy of David White Instruments)

The farm level is used by farmers for contour mapping, land leveling for proper irrigation, laying out building foundations, measuring elevations, grading, drainage, terracing and other agricultural jobs.

Automatic level - The automatic level or the self-leveling level is a highly sophisticated instrument. Once the instrument is leveled it will maintain its level automatically. This has the advantage of offering very rapid instrument set-ups and of eliminating errors in centering the level bubble in the leveling tube.

This type of level is very expensive and is used for very accurate measurements. It is mostly used by engineers in dam construction, coastal surveys, construction of missile launching sites, golf course construction and other work requiring extremely accurate, rapid measurements. (Figure 2-6)

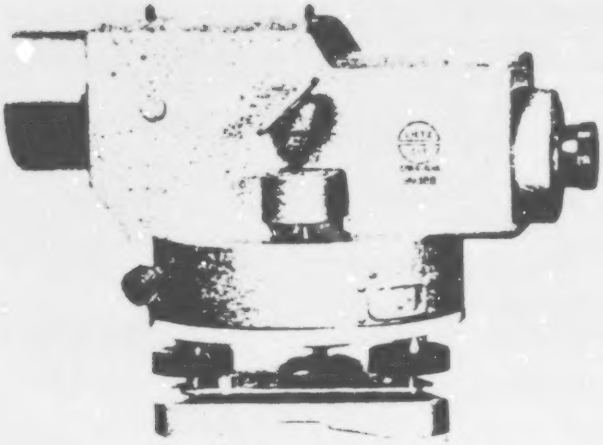


Fig. 2-6. Automatic Level

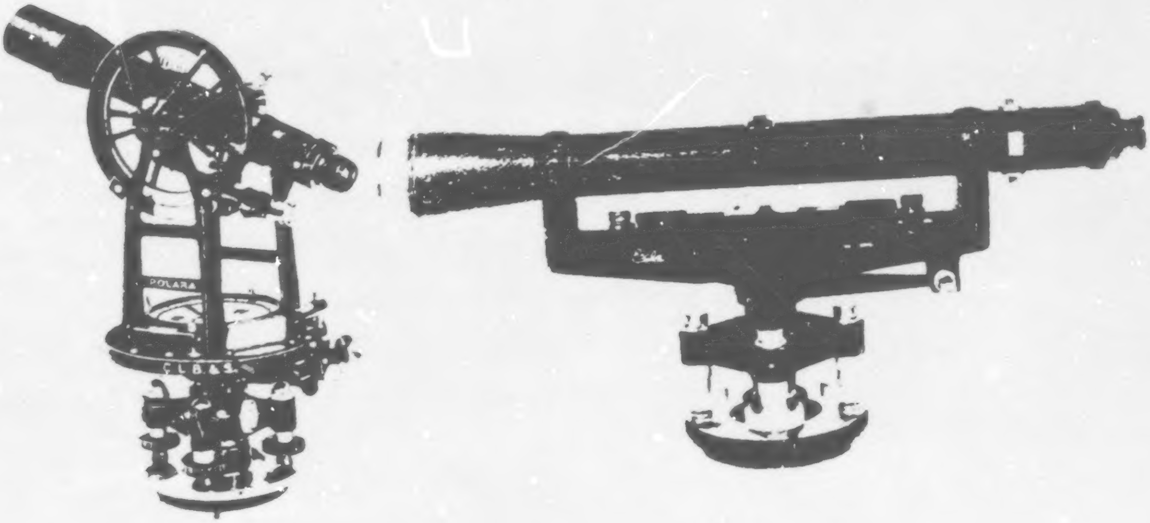
(Courtesy of Lietz)

Transit vs. level - Many people are confused as to the exact difference between a transit and a level. The difference lies in its' construction and use. (Figure 2-7)

The transit and transit-level have more uses than an ordinary level, primarily because the telescope tube is not only capable of moving 360 degrees from side to side, but can be moved up and down 45 to 360 degrees. It can measure both vertical and horizontal angles.

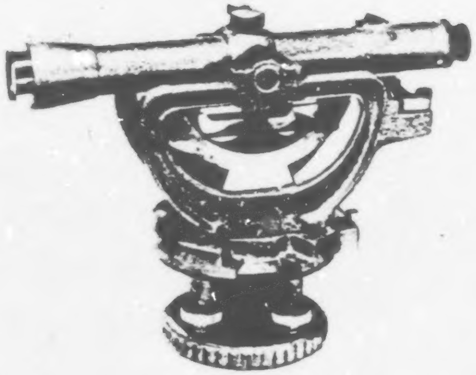
The transit and transit-level can be used to plumb walls, stake out a fence, measure vertical distances by calculation and similar operations which cannot be performed by the common level.

Additional equipment used to complement the leveling instrument includes the tripod (Figure 2-8), plumb bob (Figure 2-9), and leveling rod (Figure 2-10).



Transit

Level



Transit Level

Fig. 2-7.

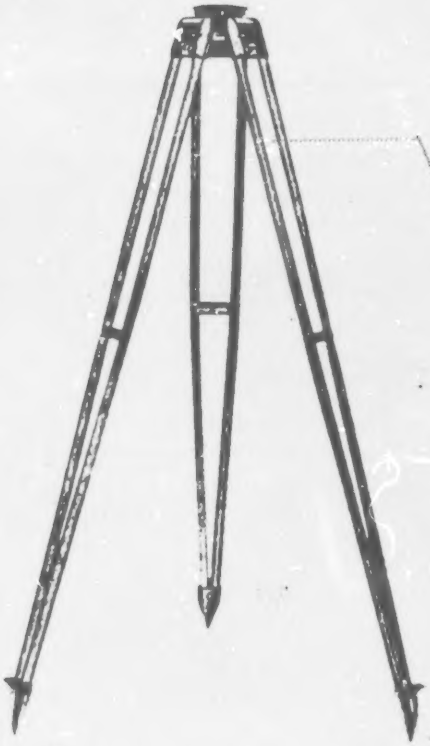


Fig. 2-8. There are wide selections of tripods to fit all classes and models of leveling instruments.

(Courtesy of David White Instruments)

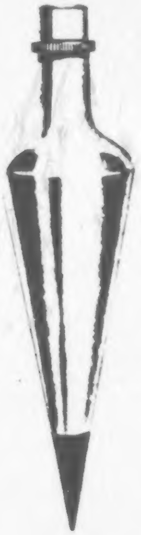


Fig. 2-9. Plumb bobs are precision machined from solid brass. They can be purchased in different weights ranging from 6 oz. to 24 oz.

(Courtesy of David White Instruments)

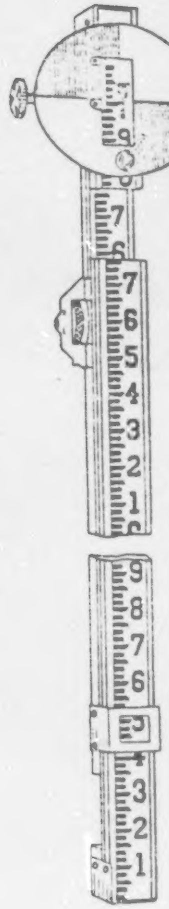


Fig. 2-10. Leveling Rod with metal target.

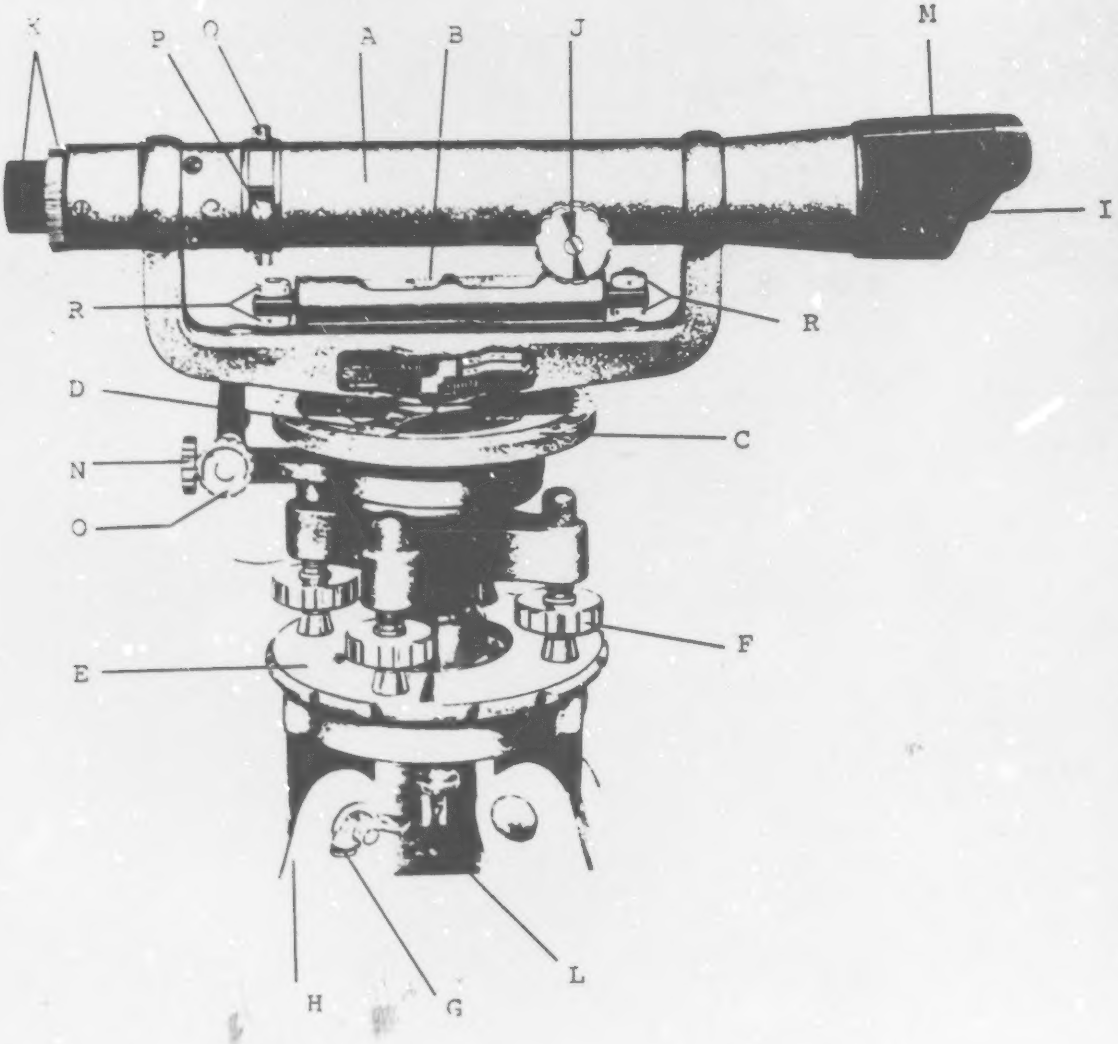
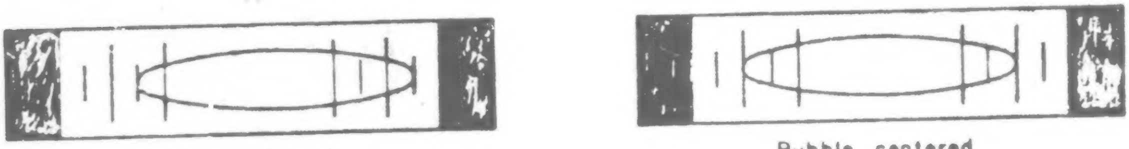


Fig. 2-11. Parts of the Leveling Instrument

A - Telescope tube
B - Level tube and bubble
C - Azimuth (degrees)
D - Index or witness mark (minutes)
E - Base plate
F - Leveling screw
G - Friction wing nut
H - Tripod leg
I - Objective
J - Objective focus screw
K - Eyepiece & cross hair focus
L - Plumb bob attachment
M - Sunshade
N - Azimuth locking screw
O - Fine adjustment (azimuth)
P - Horizontal cross hair adjustment
Q - Vertical cross hair adjustment
R - Level tube adjusting screws

Parts of a Level and Their Function:

Leveling instruments, regardless of how simple or complex, are constructed of parts which are similar in shape and function. The most obvious part of the leveling instrument is the telescope tube. This part of the level serves as a sighting device and enlarges the image of any viewed object. The telescope is a precision optical instrument containing a set of lenses that give a clear magnified image. Leveling instruments can be purchased with telescopes of varying power. A 20-power telescope makes an object seem 20 times closer than when viewed with the naked eye. Naturally, the greater the magnification, the greater the distances over which the instrument can be used. The eyepiece and cross hair focus is located at the sighting end of the telescope tube. It is used to adjust the focus on the cross hairs. The cross hair in the telescope is used to align or center the line of sight with a particular object. The objective focus screw is used for adjusting the objective lens of the telescope to focus upon the view. The objective is a compound lens that forms an image of the object being sighted. It is mounted in the telescope tube at the end opposite the eyepiece. The sunshade located at the objective end of the telescope tube, reduces glare caused by the sun. On some instruments this is an attachment while on others it is a permanent part of the tube. Directly below and parallel to the telescope tube is the level tube. This tube is an indicator of levelness of the line of sight and consists of a glass tube that is filled almost completely with liquid and sealed at both ends. The liquid is normally either alcohol or ether because neither chemicals freeze at low temperatures. The level tube is marked with graduations equally spaced from both ends. When the bubble (caused by a small amount of air riding on top of the liquid in the level tube) is centered between the graduations, the line of sight is level. (See Figure 2-12) Directly below the telescope tube is a circular plate called the azimuth. The plate is graduated in degrees. It is very much like a protractor used in school except that it makes a complete 360 degree circle. The index or witness mark identifies the degrees on the azimuth to which the telescope tube has been turned. Often times the index is marked to allow reading the azimuth to minutes of a degree.



Bubble off-center

Bubble centered

Fig. 2-12 - Level tube

Leveling instruments have four leveling screws which are supports for adjusting the level tube to the level position. The base plate is a support for these leveling screws. It also serves as an attachment to the supporting tripod legs and plumb bob. The plumb bob attachment is located on the bottom side of the base plate. It serves as a central point of attachment for the plumb bob which is used to center the instrument over a specific point. The tripod leg is one of three supporting legs to steady the instrument. The ends of the legs are steel tipped so that they may be pushed into the ground. Friction wing nuts securely clamp the tripod legs to the base plate to provide a steady support.

Proper Care of the Leveling Instrument:

The following rules of proper care and use are suggested for tripod levels:

1. Always transport a leveling instrument in its carrying case when moving from one site or location to another. Place the carrying case in a location in the vehicle where it will not receive undue vibration or jolts.
2. Carry lens and tripod caps in the instrument box after removing them to avoid loss.
3. Never force or over tighten leveling screws. Finger snugness is the rule.
4. Protect the lens from direct sun rays. Use the lens sunshade at all times.
5. Loosen tripod leg friction wing nuts before setting up or moving tripod.
6. Carry instrument when attached to the tripod under arm with instrument forward. Never carry instrument over the shoulder for fear of turning and swinging instrument into some object and damaging it.
7. Use lens tissue to clean lens -- remove dust with a camel's hair brush.

Land Measurement Equipment

The process of making measurements in leveling requires a combination of human skills and mechanical equipment applied with the utmost judgment.

Measurement of agricultural land is necessary in order to determine acreage. We do this by means of steel tapes, measuring wheels and pacing.

The idea of measuring one object by comparing it with another is probably older than written history, while the concept of measuring an object by comparing it with an "approved standard" goes back many hundreds of years. When the quantity being measured was length or distance, many "approved standard units" came into use -- the first being derived from physical dimensions of the human body. For example, the inch, palm, hand, span, foot cubit, pace, yard, and fathom can all be traced to human anatomy.

Although most people have measured objects with a "yard stick", few realize that a "king sized" yard stick or "pole" sixteen and a half feet long, was once common. This unit is also known as the "rod". Of course, the long pole proved to be a very awkward measuring tool to use, but the "rod" still remains as a common unit of land measure.

The need for a "tool" with which to measure long horizontal distance was probably first fulfilled by using a piece of rope of a known length. The increased convenience of such a flexible device in place of a long pole is obvious, but the increased convenience also introduced a new possible source of error, namely uncalibrated stretch.

Ropes were later replaced by chains of various "standard" lengths, most of them either 100 feet or 66 feet long.

With the advent of high strength steel, a narrow steel ribbon or "tape" was developed which replaced the chain. The steel tape provided greater accuracy and convenience than the chain. It also weighed less and could be marked with any desired graduations. Although chains are no longer used (except on the football field), the term "chainman" persists and probably will for years to come to identify the land measuring process by steel tape.

Land Measurement Methods:

The methods which may be used to measure distances for agricultural applications include pacing, steel tape, measuring wheel, stadia and electronic measuring equipment.

Pacing - Pacing consists of determining the average length of normal steps or paces. For example, if you counted 30 steps or paces in a length of 100 feet, your average pace would be 3.33 feet.

$$\frac{100 \text{ feet}}{30 \text{ paces}} = 3.33 \text{ feet/pace}$$

The length of the human pace varies with the individual, with the rate of speed, and the terrain. For example, a tall man's pace may be longer and slower than a short man's. An individuals pace will be longer on level and smooth terrain than it would be on rough and hilly lands. A pace of one yard length is assumed. For many individuals it is difficult to maintain this length pace uniformly and results are not satisfactory, especially for long distances. Accordingly, the best practice is to use a pace that is a natural step and an average gait.

What is the length of your pace?

The number of paces per 100 feet can be accurately determined by laying the tape (100 foot steel tape) out on a level ground surface and pacing its length at least four times. The total number of paces is divided by four to obtain the average number per 100 feet.

Taping - The steel tape is considered by many agricultural workers to be the most accurate tool for practical land measuring operations. Measuring with a steel tape is very often called chaining; in fact, the party of two men required to measure with a steel tape are often referred to as rear and head "chainmen". The accuracy of measuring with the tape is determined by the knowledge of the equipment and the skill of properly using, reading and recording measurements.

1. Reel-type steel tapes (Figure 2-13) used in most agricultural work are available with two types of graduations. One of the more common arrangements of graduating the tape is shown in Figure 2-14a. With this particular type tape there is a blank space at each end. The first foot starting with zero is graduated in

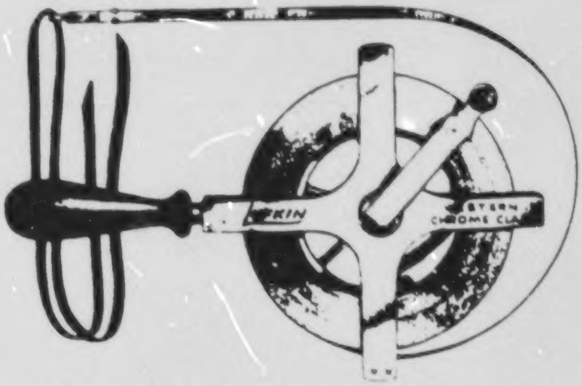
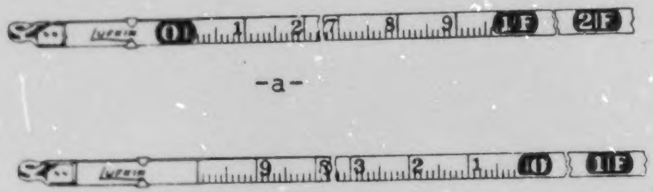


Fig. 2-13. Reel-type Steel Tape

(Courtesy of Lufkin)

10ths and 100ths numbered in a forward direction. The remainder of the tape is graduated every foot. Figure 2-14b illustrates another commonly used method in graduating steel tapes. This tape also has a blank space at each end but unlike the other tape has an extra foot before zero. This extra foot is graduated in 10ths and 100ths numbered in a backward direction. The remainder of the tape is graduated every foot.



-a-

-b-

Fig. 2-14a & b. Two commonly used methods of graduating steel tapes.

(Courtesy of Lufkin)

2. Set of eleven chaining pins (Figure 2-15) on a suitable carrying ring (Figure 2-16).

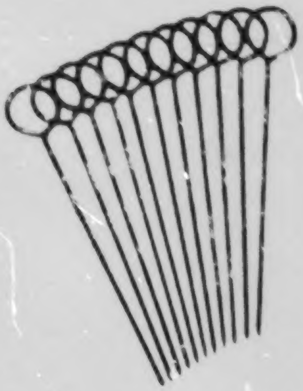


Fig. 2-15. Set of eleven Chaining Pins.

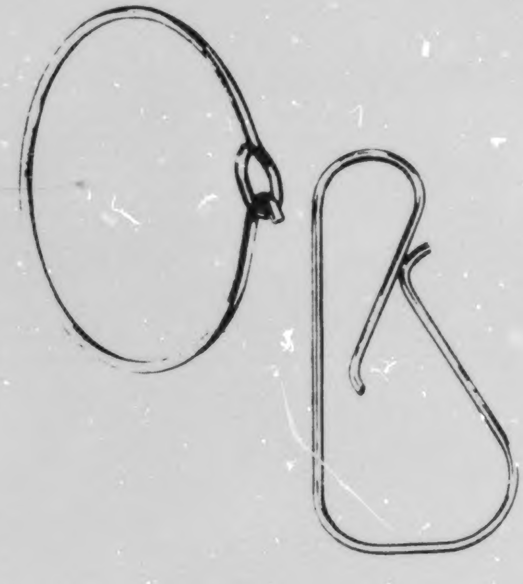


Fig. 2-16. Carrying Rings for Chaining Pins

(Courtesy of Lufkin)

3. Plumb bob - For use when measuring land that is quite rough or uneven. The plumb bob is necessary in order to measure a true horizontal distance. (Figure 2-17)

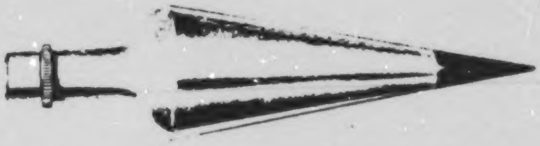


Fig. 2-17. Plumb Bob

(Courtesy of David White Instruments)

4. Range poles - Alternately painted red and white poles are used as upright guides when chaining or for marking turning points. (Figure 2-18)

The principle sources of error in measuring horizontal distances with a steel tape are:

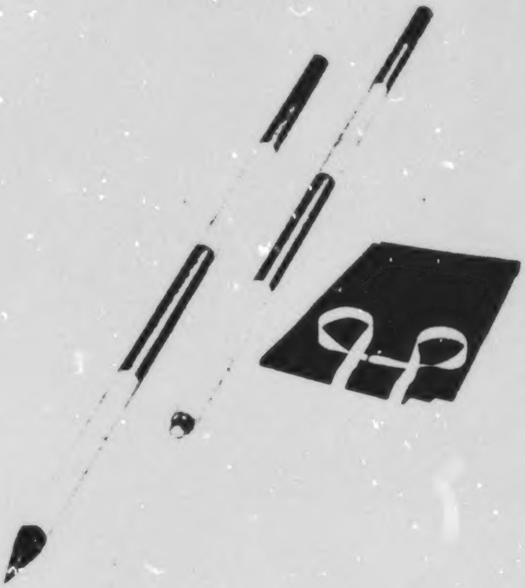


Fig. 2-18. Range Pole

1. Incorrect length of tape - Under field conditions, the actual length of a steel tape is seldom exactly its designated length. For example, the designated length of 100.00 feet will only occur when at standard temperature and tension (usually 68° F and a tension of 10-12 pounds). A tape which has been damaged and repaired may not be accurate.

   It is obvious that every tape length measured with a tape of incorrect length will be in error directly proportional to the number of tape lengths measured.

   Extreme care should be given to avoiding "kinks" in a tape since the accuracy of the tape will be destroyed. Care should also be taken to store tapes on a reel in a dry condition to prevent rust and corrosion.

2. Tape not horizontal - If a steel tape is not held level and is actually higher on one end, the distance measured will be greater than actual. For example, if one end of a 100 foot tape is 1.41 feet higher or lower than the other, the error will amount to .01 feet. If the height is doubled to 2.82 feet the error will increase to .04 feet.

   Errors of this type are cumulative and may be considerable when measuring over hilly gound.

3. Miscounting number of pins - Accuracy in chaining may be ruined by a careless count of the chaining pins. The serious mistake of omitting or adding a pin can be prevented by following an orderly procedure and careful attention to the work.

4. Incorrect tension - The error caused by applying incorrect tension is relatively unimportant. An increase of 10 lbs. in tension on a light tape (1 lb) will stretch a 100 foot tape about 0.013 feet. The same increase on a heavy tape (3 lbs), will produce a change in length of about 0.003 feet.

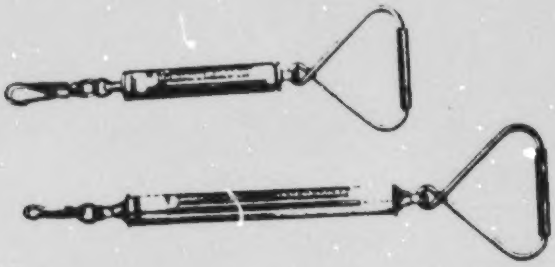


Fig. 2-19. Proper tension is applied to the tape by use of a spring scale.

(Courtesy of Lufkin)

   On work requiring accurate measurements, a spring scale is used for maintaining a constant tension.(Figure 2-19)

5. Sag - As the tape is lifted from a flat surface sag in the tape will shorten the distance between the two ends. A sag in the center of a 100 foot tape can cause an inaccurate measurement. A 5/16" tape normally sags about 7 3/8 inches below the two ends and will cause the measured distance to be short by 0.01 feet. Error can be eliminated by always applying equal tension, thereby compensating for the effect of sag by adding above correction factor to each tape length.

6. Incorrect alignment - If a field measurement comprises more than one tape length and the points marking the ends of the various lengths along the route are not along a straight line, the measured distance will be in error. For measurements of high precision the tapemen can be kept on line with a level (transit).

7. Tape not straight - If the steel tape is not stretched straight, as when it is being bent either horizontally or vertically around trees or bushes, or is blown by a strong wind, the measured length will be too great. For example, if the middle point of a 100 foot steel tape is 8½ inches off line, the resulting error in length is 0.01 feet. (The least error will occur when the bend is near the middle of the tape.)

8. Random errors - Random errors are introduced into taping from several causes. These errors include: (1) failure to apply proper tension, (2) wind deflecting the plumb bob, (3) inability of the tapeman to steady the plumb bob, (4) inability of the observer to estimate the last place in reading between tape graduations, and (5) others.

Measuring Wheels - One of the quickest and easiest methods of measuring distances is the measuring wheel (Figure 2-20). The measuring wheel is designed to measure distances on flat or smooth surfaces and can be operated while walking or driving a vehicle (Figure 2-21).

Distances are measured using the measuring wheel by multiplying the number of revolutions recorded on the counter by the circumference of the wheel. For example, if the counter reads 7 revolutions and the wheel circumference is 6.6 feet, the distance covered is 46.2 feet.

Fig. 2-21. Using the Measuring Wheel while operating a vehicle

(Courtesy Rolatape, Inc.)

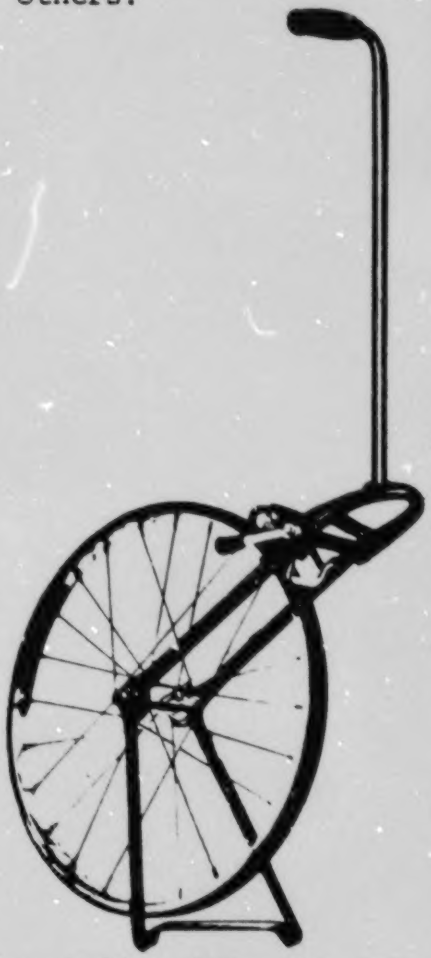


Fig. 2-20. Measuring Wheel

(Courtesy Rolatape, Inc.)

EXAMPLE:

Circumference of Wheel	6.6 feet
Revolution of Wheel	x7
	46.2 feet

Acreage measurements are obtained simply by multiplying the number of revolutions in the length of the field by the number of revolutions in the width. Each revolution of the wheel is recorded on an automatic counter; divide the answer by 1000 by moving the decimal three places to the left.

EXAMPLE:

Length of Field	125 revolutions
Width of Field	x 30 revolutions
	3750 revolutions
Acreage =	3.750 acres

Stadia - The stadia method of measurement provides a rapid and efficient means of determining distances and differences in elevation. It can be used in agriculture for contouring and also differential and profile leveling.

The term "stadia" comes from the Greek word for a unit of length originally applied in measuring distances for athletic contests. "Stadia" is now used to describe the cross hairs in some leveling instruments as well as to the stadia method itself. Not all leveling equipment is equipped with stadia hairs.

A more detailed discussion of measuring lineal distances by stadia is presented in Unit III.

Electronic measuring equipment - Electronic measuring instruments called geodimeters (Figure 2-22) are used when an extremely accurate measurement is needed. The maximum error using this instrument for a single measurement is .005 feet/mile, which is less than 1/16 inch per mile. Here is how it works: The geodimeter projects a modulated beam of light to a reflector (Figure 2-23) which is placed at the opposite end of the distance to be measured. The light is reflected back to the instrument where a comparison is made between the outgoing and incoming light pulses. The geodimeter can be used to measure distances across water, along roads, and in cities and construction areas (Figure 2-24) where there are no obstructions to the light beam.

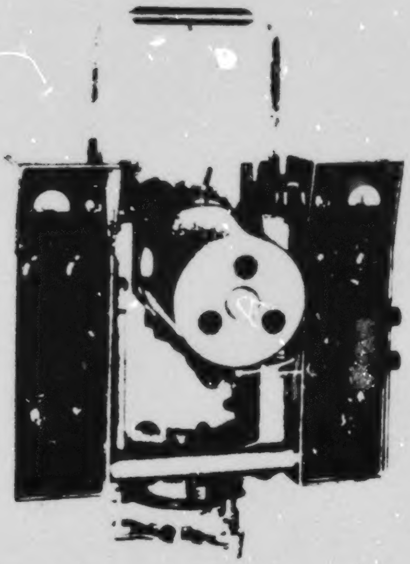
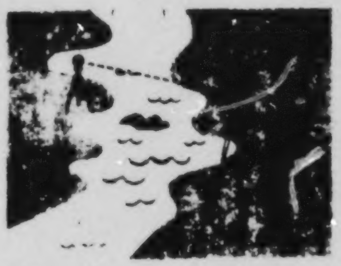
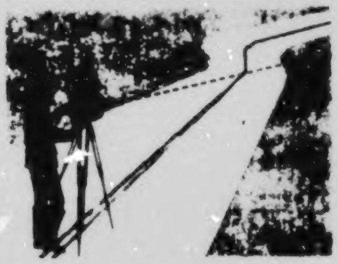


Fig. 2-22. Geodimeter

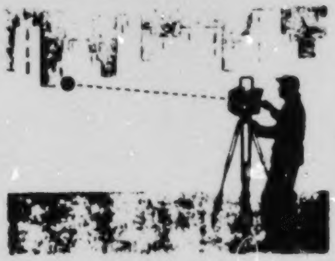
(Courtesy of Surveyors Service Company)



ACROSS WATER
Bridge and dam construction. No interference from surface reflections or passing ships.



ALONG ROADS
Accuracy unaffected by passing traffic, power lines, etc.



IN CITIES AND CONSTRUCTION AREAS
City surveying and boundaryline measurement are typical surveying jobs for AGA Geodimeter.

Fig. 2-24. The Geodimeter can be used to measure distances across water, along roads, and in cities and construction areas.

(Courtesy of Surveyors Service Company)

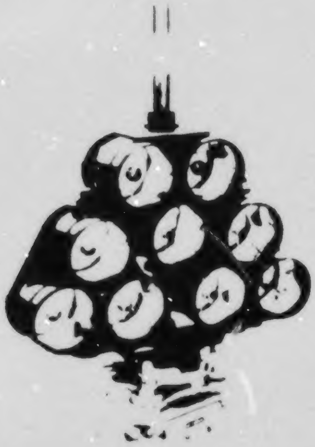


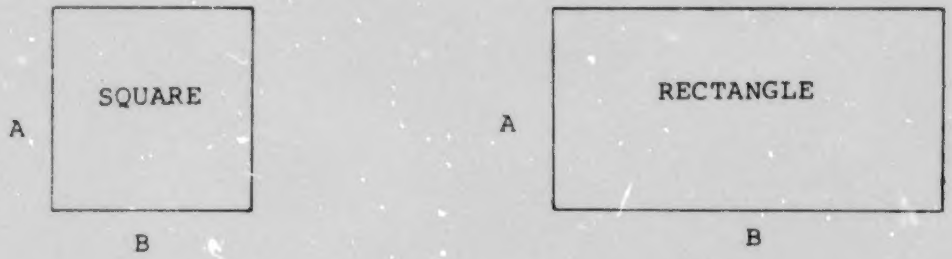
Fig. 2-23. Reflector

(Courtesy of Surveyors Service Company)

Determining Land Acreage

Land measuring applications in agriculture are directly related to determining field boundries and the exact quantity of land expressed in acres contained within the boundries. An acre of land is expressed in numerical terms as 43,560 square feet projected in a horizontal line of sight. Providing the lineal distance in feet is known, one may obtain square feet by applying the mathematical principles of geometry. The following examples of determining acreage are typical of most agricultural applications.

Field or land areas that are square or rectangular in shape can be converted to acreage by first multiplying the width in feet times the length in feet and dividing the product by the number of square feet in an acre.



A x B = Area

EXAMPLE: Mr. Smith has a barley field 2,000 feet long and 500 feet wide. What is the area of his barley field?

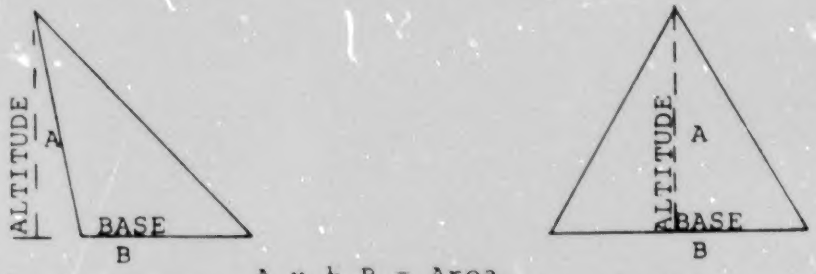
Area = length x width
Area = 2000 ft. x 500 ft. = 1,000,000 sq. ft.

To convert this to acres divide 1,000,000 sq. ft. by 43,560 sq. ft./acre

$$\frac{1,000,000 \text{ sq. ft.}}{43,560 \text{ sq. ft./acre}} = 43.56 \text{ acres}$$

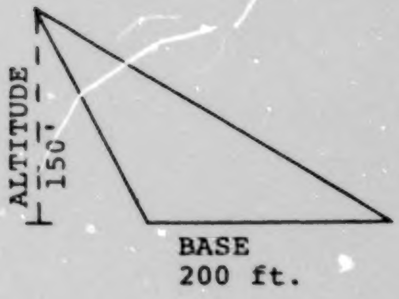
Mr. Smith has 43½ acres of barley

Similarly the area of a triangularly shaped area will be equal to one-half the base times the altitude.



A x ½ B = Area

EXAMPLE: Mr. Jones has a corn field shaped like a triangle and wants to find its area. How does he do it?



Area = altitude x ½ base

Area = 150 ft. x $\frac{200}{2}$ ft

Area = 150 ft. x 100 ft.

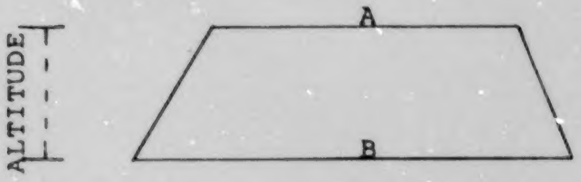
Area = 15,000 sq. ft.

To convert this to acres divide 15,000 sq. ft. by 43,560 sq. ft./acre

$$\frac{15{,}000 \text{ sq. ft.}}{43{,}560 \text{ sq. ft./acre}} = .34 \text{ acres}$$

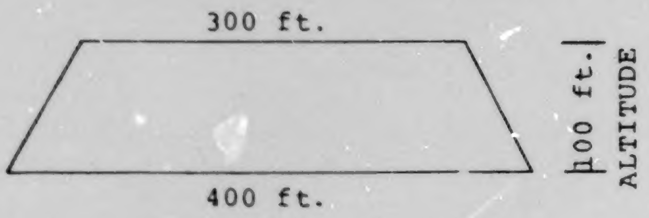
Mr. Jones has about 1/3 of an acre of corn.

The area of a field with two sides parallel is found by measuring the lengths of two parallel sides, adding them together, dividing by two to determine the average length, and then multiplying this by altitude or width.



(A+B) ÷ 2 x Altitude = Area

EXAMPLE:



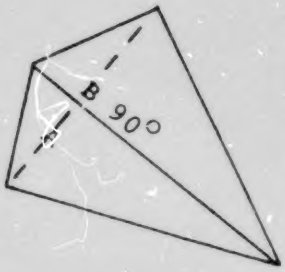
Area = (400 ft + 300 ft) ÷ 2 x 100 ft.
Area = 700 ft ÷ 2 x 100 ft.
Area = 350 ft. x 100 ft.
Area = 35,000 sq. ft.

To convert this to acres divide 35,000 sq. ft. by 43,560 sq. ft./acre

$$\text{Acres} = \frac{35{,}000 \text{ sq. ft.}}{43{,}560 \text{ sq. ft./acre}}$$

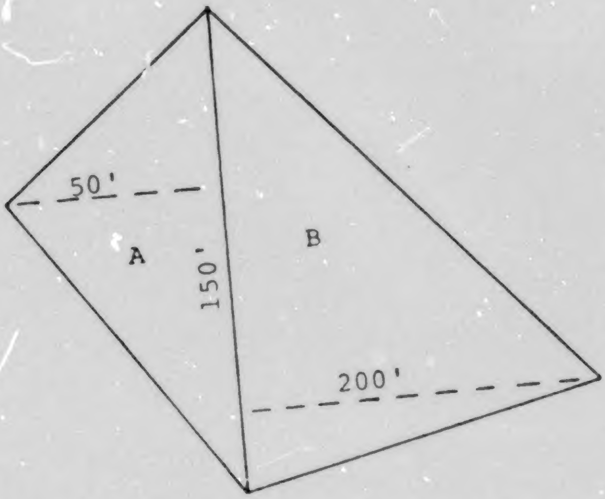
Acres = .80 or 8/10 of an acre

To find the area of a field having four or more sides, divide it up into triangles, figure the area of each triangle separately, and then add them together.



Area Triangle A + Area Triangle B in sq. ft. = Area

EXAMPLE:



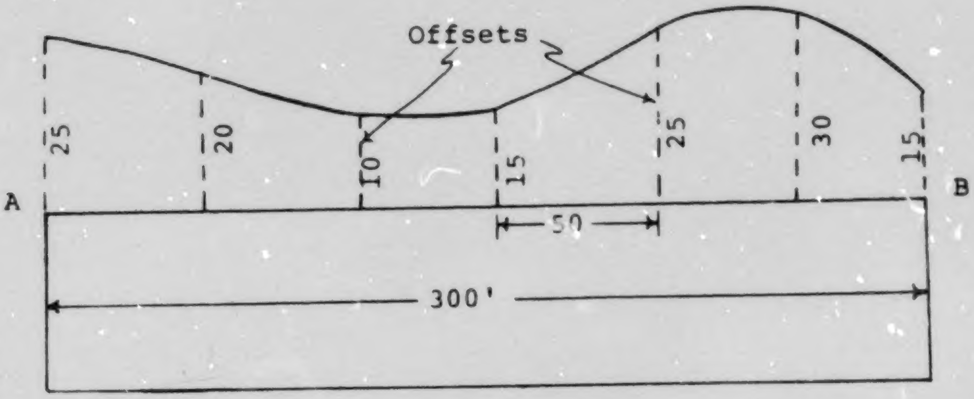
Area of Triangle A = 3750 sq. ft.
Area of Triangle B = 15,000 sq. ft.

Total area of field = area triangle A + area triangle B
= 3750 sq. ft. + 15,000 sq.ft.
= 18,750 sq. ft.

To convert this to acres divide 18,750 sq. ft. by 43,560 sq. ft./acre

$$\frac{18{,}750 \text{ sq. ft.}}{43{,}560 \text{ sq. ft./acre}} = .25 \text{ or } 1/4 \text{ acre}$$

If one boundary of a field is an irregular curved line, one or more straight lines, such as AB, should be laid out. Offsets perpendicular to AB, as shown by short dotted lines at uniform intervals, should be measured. The area between lines AB and the curved boundary is measured as follows: Take the sums of the two end offsets and divide by two; to this add the sum of all other offsets and multiply by the uniform distance between offsets.



EXAMPLE: Line AB is 300 feet long and the lengths of the offsets are 25, 20, 10, 15, 25, 30 and 15 feet as shown. The uniform spacing between offsets is 50 feet; the sum of the two end offsets $\frac{(25 + 15)}{2} = 20$; then 20 + 20 + 10 + 15 + 25 + 30 = 120 feet.

Area = 120 x 50 = 6,000 sq. ft.
No. Acres = 6,000 ÷ 43,560 = .13 acres
Area of the remaider of field is calculated according to its shape.

UNIT III

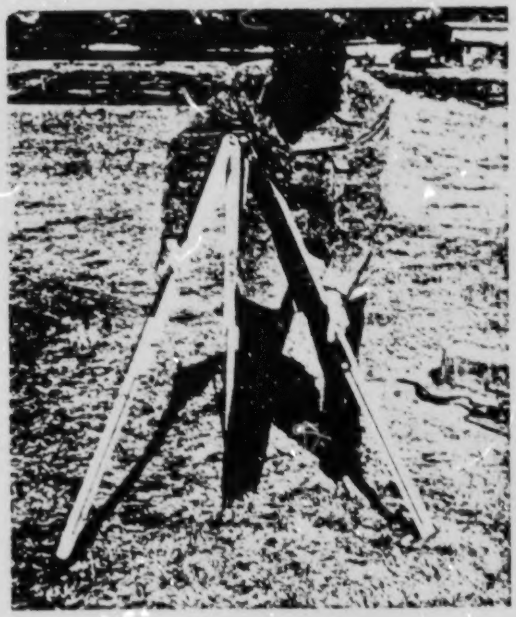
USING LEVELING AND LAND MEASURING EQUIPMENT

To obtain consistantly accurate work when using leveling and measuring equipment the operator must not only know how to set up and operate the various tools but must be capable of visualizing the process as the operations are performed. To avoid omissions in procedure, experienced surveyors develop a specific procedure of performing their work. It is the purpose of this unit to describe procedures for using the tripod level and the steel tape for leveling and measuring operations.

The Tripod Level

Learning how to operate the tripod level is not a difficult task. However, to obtain consistently accurate results the level must be handled, operated and cared for properly. Perhaps the most important part of learning how to use the level is to know the techniques of setting it up properly so that sighting will be accurate. The following steps of procedure should be taken in setting up the tripod level correctly.

Step I



First, set up the tripod and adjust the head to an approximate level setting. This operation reduces the need for large adjustments when leveling the instrument to an accurate setting.

To set up the tripod, loosen the tripod wing nuts to remove friction from the legs, spread the legs 3 to 4 feet apart and push them firmly into the ground. Adjust the legs accordingly to bring the head of the tripod to a rough setting. Estimate the levelness of the head to a level line in the distant horizon and match the head of the tripod to this line. A fence or building may also be used as a guide. If the ground is sloping, place two legs of the tripod down slope. It may be necessary to move the legs up or down hill to obtain a rough setting of the tripod head. Remove the thread protection cap and place it in the instrument case.

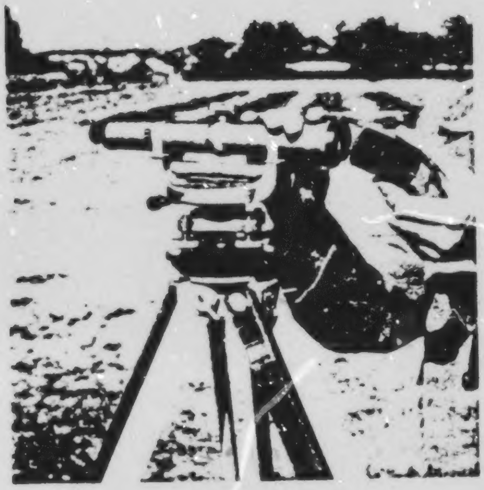
Step II

Remove instrument from its case. Pick up the instrument by the base to prevent damage to the delicate telescope tube.

Step III

Attach instrument to tripod. Hold the instrument in one hand while turning the base with the other hand. Tighten the base snugly with hand -- do not force.

Step IV

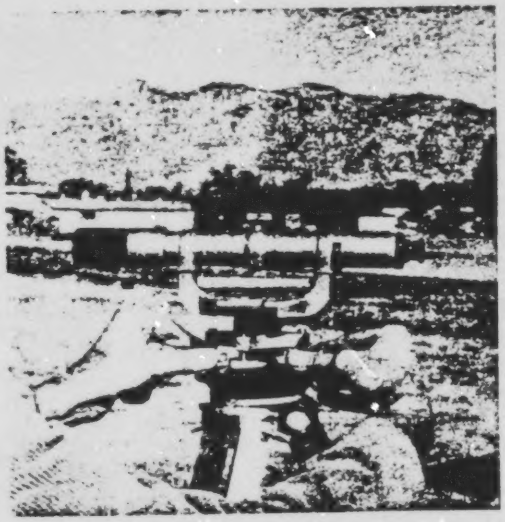


Remove the lens protection cap and place it in the instrument case and attach sunshade to the telescope tube. The sunshade is used to reduce reflection and glare.

Step V

Check the location of the setting. Sight through the instrument to determine whether the level will come within limits of the rod. If not move to a new location. If the rod can be read proceed to Step VI.

Step VI



Level instrument to an accurate setting. Rotate the telescope tube in alignment with two leveling screws. Grasp the two leveling screws between the thumb and forefinger of each hand; rotate the leveling screws by bringing the thumbs of the hand toward or away from one another. The bubble in the level tube will follow the movement direction of the left thumb. (Figures 3-1 and 3-2) Keep the shoes of the four leveling screws pressed firmly on the backing plate but avoid binding. Place the telescope tube over the second set of leveling screws and repeat the leveling operation. Recheck and make changes as necessary through the 360 degree azimuth circle. Caution: Do not overtighten the adjusting screws.

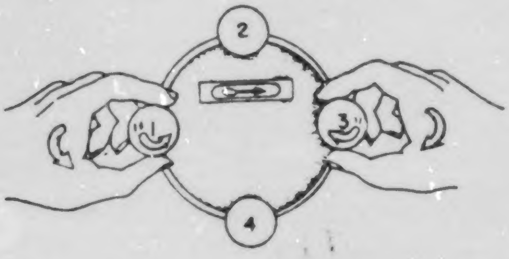


Fig. 3-1. Turning both leveling screws "in" moves the bubble to the right.

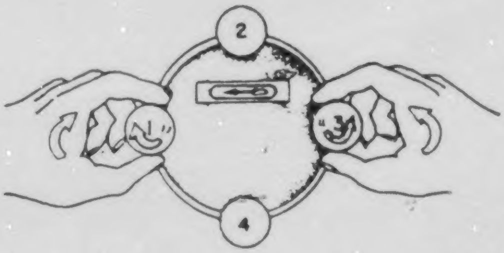
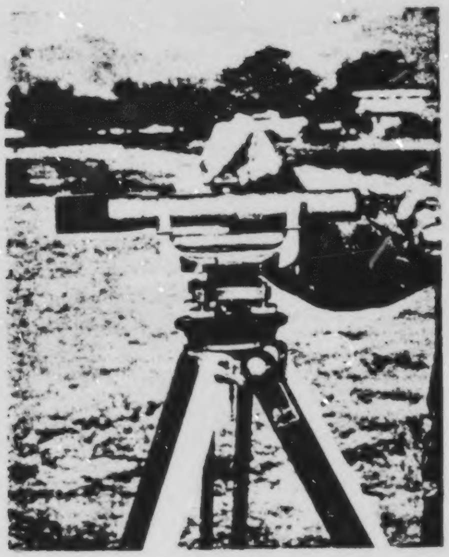


Fig. 3-2. Turning both leveling screws "out" moves the bubble to the left.

Adjust eyepiece and objective focus. Aim the telescope tube at an unmarked object such as the sky and adjust the eyepiece until the cross hairs are in sharp focus. To adjust the objective focus, aim the telescope tube at an object and adjust the objective focus until the object is clearly visible.

Step VII



Testing the Tripod Level for Proper Adjustment:

The leveling instrument can be bumped or jolted out of adjustment. When the line of sight and the bubble of the level are not exactly coordinated, the sightings taken will be incorrect. When this happens it is then necessary to check and if necessary adjust the instrument to insure that the line of sight is level.

The procedure for checking the level for adjustment using the "two peg" test is as follows:

Step I On a fairly level area, drive two stakes (A & B) into the ground approximately 300 feet apart.

Step II Set the level in such a position that the eyepiece is approximately one inch or less in front of the rod held on top of Stake A. Level the instrument to where the bubble in the level tube indicates the instrument to be level.

Step III Take a rod reading on Stake A, sighting through the objective end of the telescope tube. Next, set the rod on top of Stake B and sighting through the eyepiece take a rod reading at Stake B. The difference between the two readings will be the difference in elevation plus or minus the error of adjustment.

Step IV Move the level to Stake B, set up as before, and take a rod reading on Stake B sighting through the objective end. Sighting through the eyepiece take a sighting on Stake A. As before, the difference between the two sightings is the difference in elevation of Stake A and B plus or minus the error of adjustment.

Step V The true difference in elevation of points A and B is determined by adding the difference in elevation determined in Step III and IV and dividing by two. This will give a mean of the two results. Knowing the true difference in elevation between the two points and the height of instrument at Stake B, the correct rod reading at Stake A can be computed by subtracting the true difference in elevation from the rod reading at Stake B. This calculation gives a level sight. If the instrument is out of adjustment the rod reading taken on A from the instrument on Stake B will differ from the calculated reading.

Instrument at A

Rod-reading on A = 4.062
Rod-reading on B = 5.129

Difference in elevation of A and B 1.067

Instrument at B

Rod-reading on B = 5.076
Rod-reading on A = 4.127

Difference in elevation on B and A 0.949

Mean of two differences in elevation =

$$\frac{1.067 + 0.949}{2} = 1.008$$ true difference in elevation

Instrument is now 5.076 above B

Rod-reading at A should be 5.076 - 1.008 = 4.068 to give a level sight.

Amount of adjustment needed

Rod-reading at Stake A from instrument on B = 4.127
Reading to give level sight = 4.068

Adjustment necessary .059

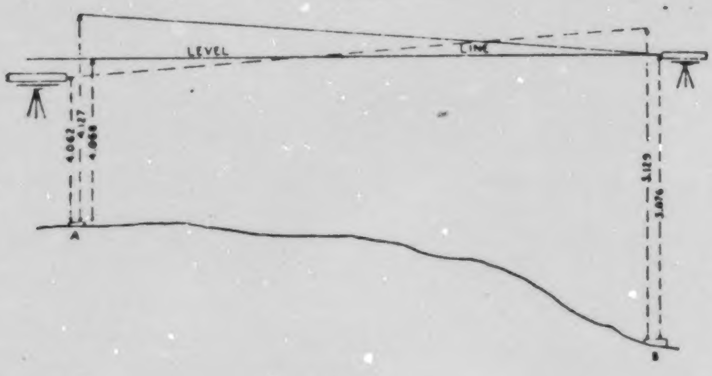


Fig. 3-3. Two Peg Adjustment

Checking the Horizontal Cross Hair:

Checking the horizontal cross hair adjustment can be easily performed while the level is still set up and leveled at Stake B and sighted at the target on the rod held on Stake A. Be sure that the center of the horizontal cross hair bisects the target; then rotate the level back and forth slightly from side to side. If the ends of the cross hair cut the target in the same place as did the center of the cross hair, it is in adjustment. If the ends of the cross hair do not remain on the spot as did the center, the cross hair should be adjusted. A second and perhaps quicker method of checking the horizontal cross hair is to sight on a building's point. If the cross hairs are not in accurate horizontal adjustment the horizontal cross hair lines will not superimpose on the point as the telescope is turned. Usually, if the cross hairs need adjustment, it is best to have it done by someone experienced in the adjustment and repair of surveying equipment. (See Figure 3-4)

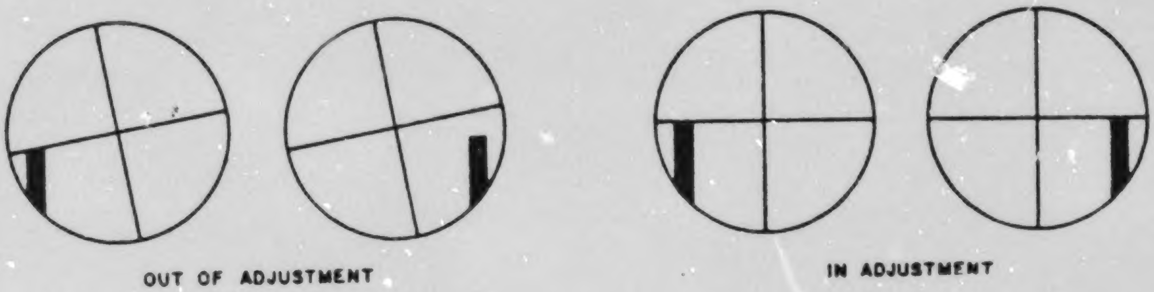


Fig. 3-4. Adjustment of horizontal cross hairs.

The Leveling Rod

Leveling rods are used with a leveling instrument to take and read vertical measurements. Leveling rods are classified either "self-reading" or "target" rods or a combination of the two. Self-reading rods are read directly from the instrument by the instrument man. Target rods utilize a sliding target mounted on the rod. The instrument man instructs the rod man to move the target until the instrument cross hairs, as viewed through the telescope, bisect the target. The rodman then reads the rod. Most leveling rods consist of two or three sections of hardwood 4 to 7 feet in length which permit the rod to be extended to approximately thirteen feet. The rod shown in Figure 3-5 is a three section or San Francisco Rod. The two section leveling rod, which will be discussed in this unit, is also known as the Philadelphia Rod. (See Figure 3-6)

Reading the Leveling Rod:

The following drawings illustrate a rod and target. Major divisions of the rod in feet are shown in large red numbers with the number one starting at the bottom of the rod. Between each foot indicator are nine (9) numbers in black.

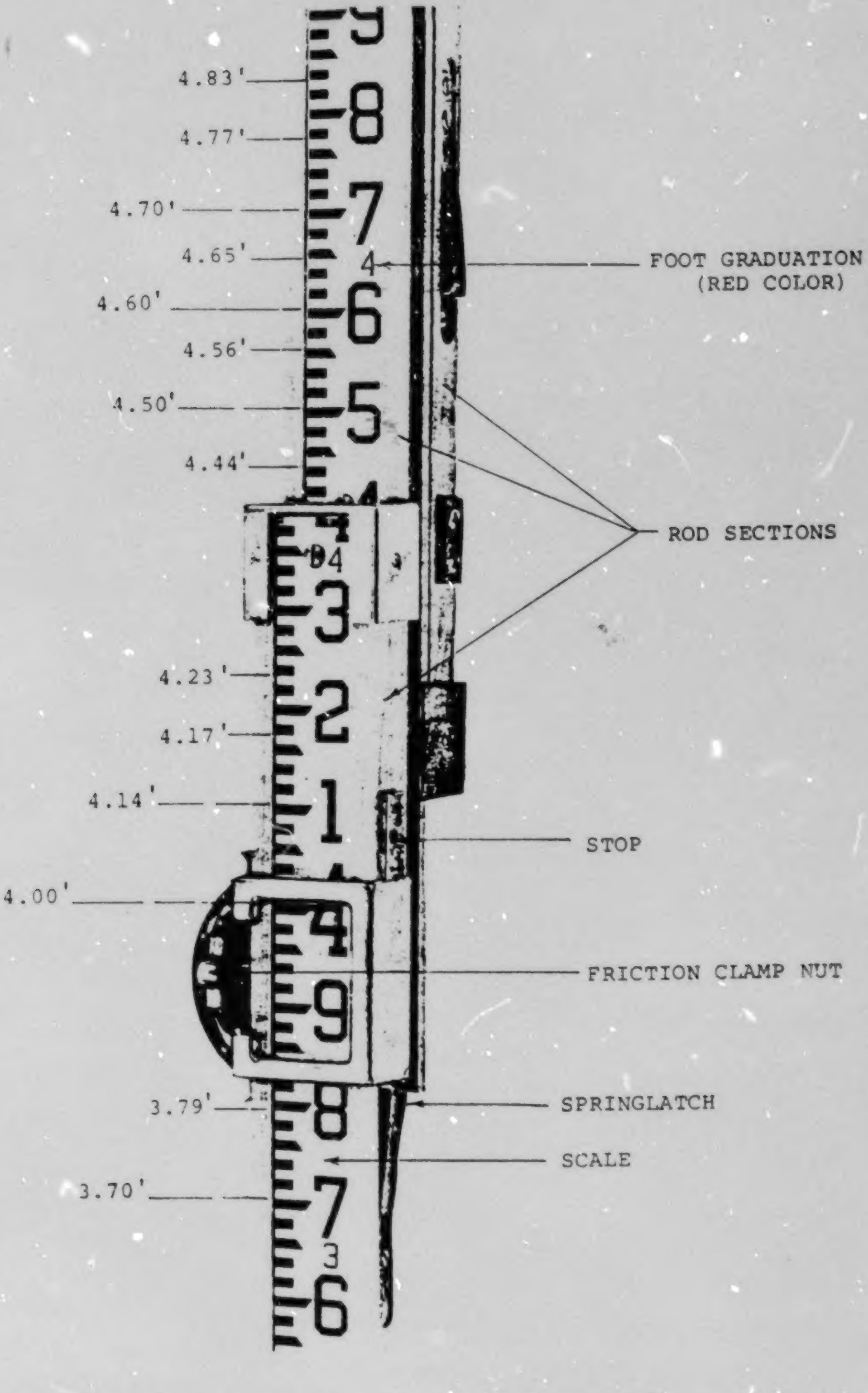
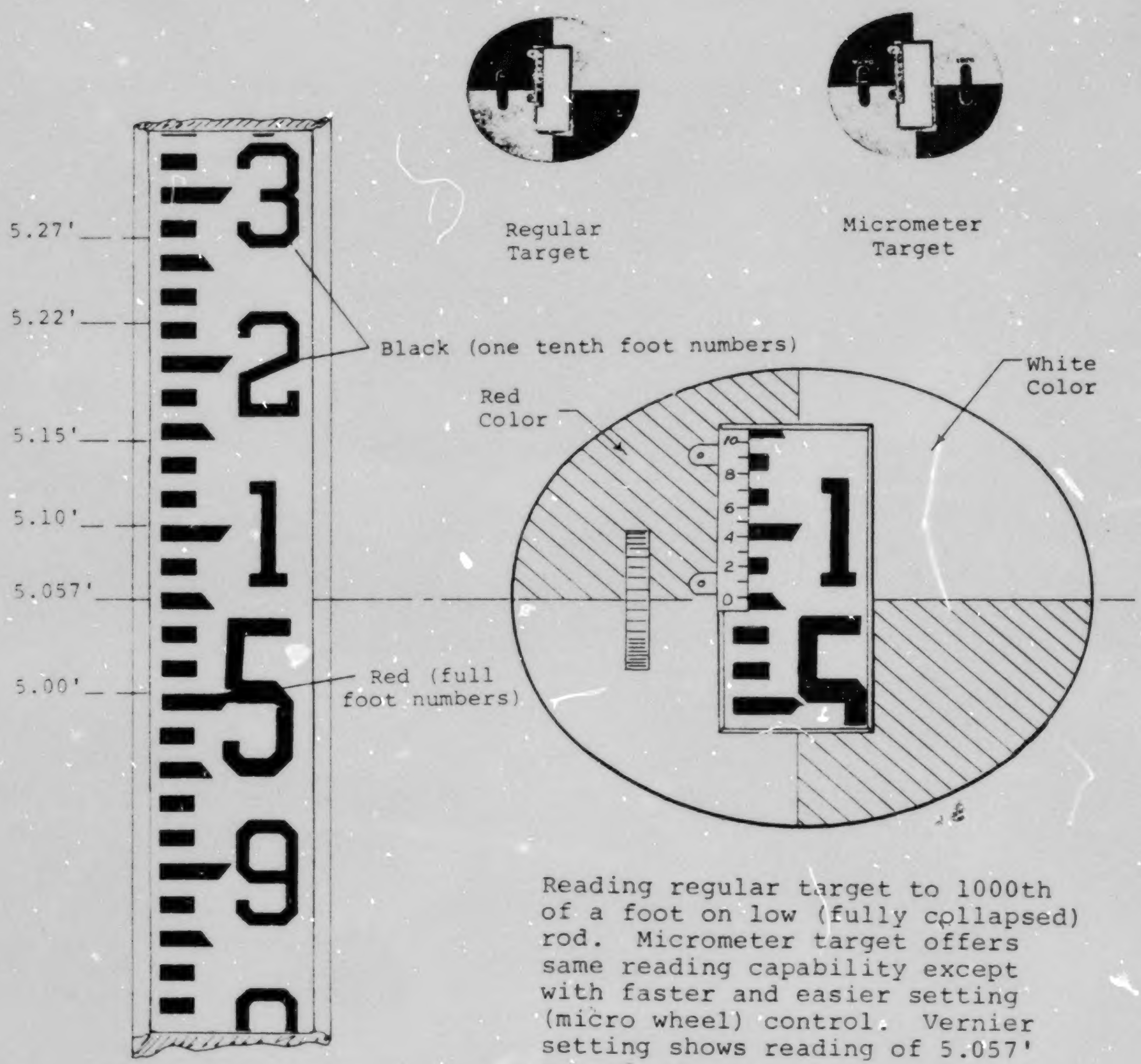

4.83'
4.77'
4.70'
4.65'
4.60'
4.56'
4.50'
4.44'
4.23'
4.17'
4.14'
4.00'
3.79'
3.70'
FOOT GRADUATION
(RED COLOR)
ROD SECTIONS
STOP
FRICTION CLAMP NUT
SPRINGLATCH
SCALE

Fig. 3-5. Three section San Francisco Rod
(Courtesy of Lietz)


5.27'
5.22'
5.15'
5.10'
5.057'
5.00'
3
2
1
5
9
Black (one tenth foot numbers)
Red (full foot numbers)
Red Color
White Color
10
8
6
4
2
0
1
5

Regular Target

Micrometer Target

Reading regular target to 1000th of a foot on low (fully collapsed) rod. Micrometer target offers same reading capability except with faster and easier setting (micro wheel) control. Vernier setting shows reading of 5.057' on rod.

Fig. 3-6. Philadelphia Rod and targets

Opposite each of the numbers is a wide black line to indicate that these points are one tenth (.10) of a foot measurement. Between each of tenth's numbers are four (4) black spaces and five (5) white spaces. Each of the equal width spaces represents one hundredth (.01) foot distance. (Figure 3-6).

Extending the Leveling Rod:

Often times the terrain being traversed will require extending the rod to avoid moving the instrument to a new location. Errors can easily occur should the rodman not extend the rod to its maximum length. Partial extension will destroy the continuity of scale readings when the instrument man is reading the rod. The rodman should continuously check to make sure that the rod clamps are securely and accurately locked.

Using the Target:

A target is useful when operations require (1) determining the land position where the elevation is the same, (2) setting stakes in the soil to the same elevation and (3) when the rodman is accurately reading the rod. In the latter case, a vernier attachment to the target permits readings to 1/1000 of a foot. For readings up to 7.00' the Philadelphia Rod is clamped into the low (fully collapsed) position. The target can then be pre-set or read to 1000th or a foot. To obtain rod readings above 7.00' the clamp has a built-in vernier enabling the user to pre-set or record an elevation (reading to 1000th of a foot). When used this way, the target is accurately affixed at the 7.00' mark - and then read by referral to the reversed scale on the back face of the rod. Thus target readings between 7.00' and 13.00' can be obtained or set. (See Figure 3-6)

Holding the Leveling Rod:

The rodman should hold the rod in a vertical position at all times when it is being used. A good rodman usually stands as straight as possible with the bottom of the rod on the ground directly between the toes of his shoes and slightly in front of them. The rod is then "plumbed" by lining it up with the rodman's body. The hands are positioned with the fingers up and palms on either side of the rod to prevent any interferance in reading the rod.

Field Signals

Usually the instrument man and the rodman are far enough apart that a system of signals may be helpful. The signals used may be varied to fit the situation, but all signals used should be well understood in advance by all members of the party. Here are some suggested signals:

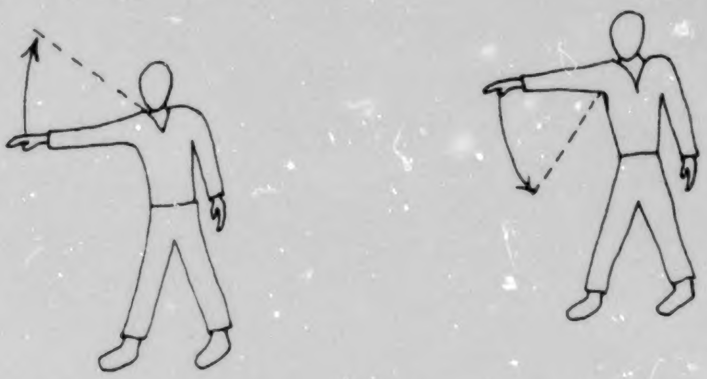


Fig. 3-7

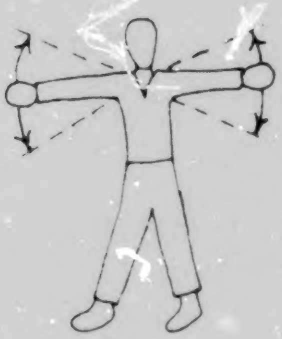


Fig. 3-8

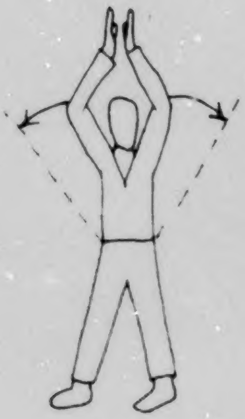


Fig. 3-9

"Up or "Down" - Usually used by the instrument man to request the rodman to raise or lower the target on the rod or to move up or down slope in certain work with contours. The instrument man motions to the rodman by raising his arm above his shoulder for an upward motion and dropping his arm below his waist for a downward motion. A slow motion indicates that the move should be a considerable distance. A quick motion is for a short distance. (Figure 3-7)

"Alright" - The instrument man extends both hands horizontally and moves them up and down. At close range he may simply show the palms of both hands. (Figure 3-8)

"Plumb the Rod" - (Hold the rod exactly upright.) Extend arms full length above head and move them slowly in the direction required as shown by the vertical cross hair.

If the rod is not being held plumb in a direction perpendicular to the line of sight, the instrument man can see that it does not line up with the vertical cross hair of his telescope. However, when the rod is out-of-plumb in the same plane as the line of sight, the instrument man will signal the rodman to move the top of the rod slowly back and forth in a plane toward or away from the instrument. The reading will be higher if the top of the rod is forward or rearward of plumb position. Thus, when the rod is waved forward and backward through the plumb position, the correct reading is the smallest reading observed. (Figure 3-9)

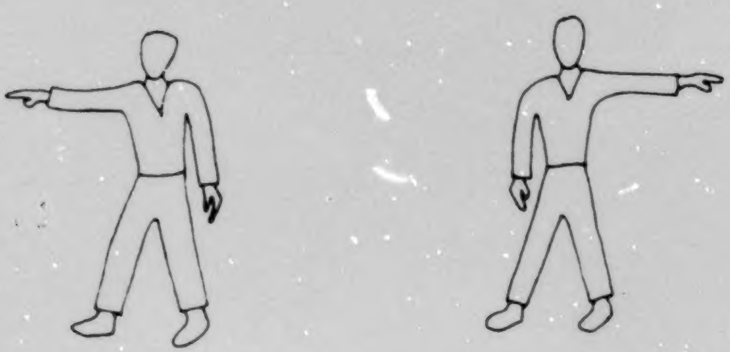


Fig. 3-10

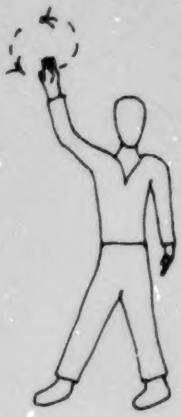


Fig. 3-11

"Move to Right or Left" - Extend the hand in the direction wanted. (Figure 3-10)

"Take a Turning Point" - The arm is swung slowly in a circle above the head. (Figure 3-11)

Leveling Terms and Field Notes

Of all the operations accomplished by a leveling party, the most important is note keeping. It is obvious that no matter how carefully the leveling operation is done or how experienced the leveling party may be, all is rendered valueless if the field notes are incomplete or unclear. Leveling terms assist the note keeper in keeping legible notes. It is the purpose of the following discussion to describe the standard method of logging data which at a later date can be clearly understood by the original leveling party or others knowledgeable in their interpretation.

Leveling Terms:

Bench Mark - (Abbreviated BM). A permanent reference point for which the elevation is known or assumed. For agricultural work a concrete well curb, the corner of a road culvert, or other convenient and relatively permanent point may be chosen. It is convenient to assign it an elevation, such as 100 feet. All measurements are then relative to this point of reference.

Backsight - (Abbreviated BS). This is a rod reading taken on a point whose elevation is known. A backsight reading is the vertical height of the level line of sight above the known elevation. The elevation of the line of sight can then be computed.

Height of Instrument - (Abbreviated HI). This is the elevation of the level line of sight. It is obtained by adding the backsight reading to the known elevation of the point upon which the backsight is taken.

Foresight - (Abbreviated FS). It is a reading taken on a new point to determine its elevation. The foresight reading is the vertical height of the new point in relation to the level line of sight. The elevation of the new point can then be computed when the height of instrument is known.

Turning Point - (Abbreviated TP). This is a temporary point of known elevation. When it becomes necessary to move the instrument to a new location in order to read the rod, the last rod setting is held at the last point for which the elevation has been determined. This becomes a Turning Point. The turning point therefore serves as a reference for calculating a new height of instrument when the instrument is moved to a more advantageous location for continuing the survey.

Taking Field Notes:

Surveying "field notes" are a record of sightings made on the rod (rod reading). If the notes are incomplete, incorrect or destroyed, much or all of the time spent in making accurate measurements may be lost. A field book containing information gathered over a period of weeks is worth thousands of dollars, assuming that it cost $150-$200 per day to maintain a party of four men in the field.

Field notes maintained by the instrument man should contain a complete record of all measurements made during the progress of the day's work on the survey. Four types of notes are kept: (a) sketches, (b) tabulations, (c) description, and (d) combination of these. Care should be taken in lettering the field notes. Field notes should be clear and convey only one correct interpretation. Field notes are never transferred from one book to another. Make all notes as legible as possible in the field book used during the survey. Any errors made in the field book are never erased, but should have a line drawn through them, with the correction notes.

Arrangement of Notes:

The first page of the notebook is the index. Figure 3-12 is an example of how the index page should be completed:

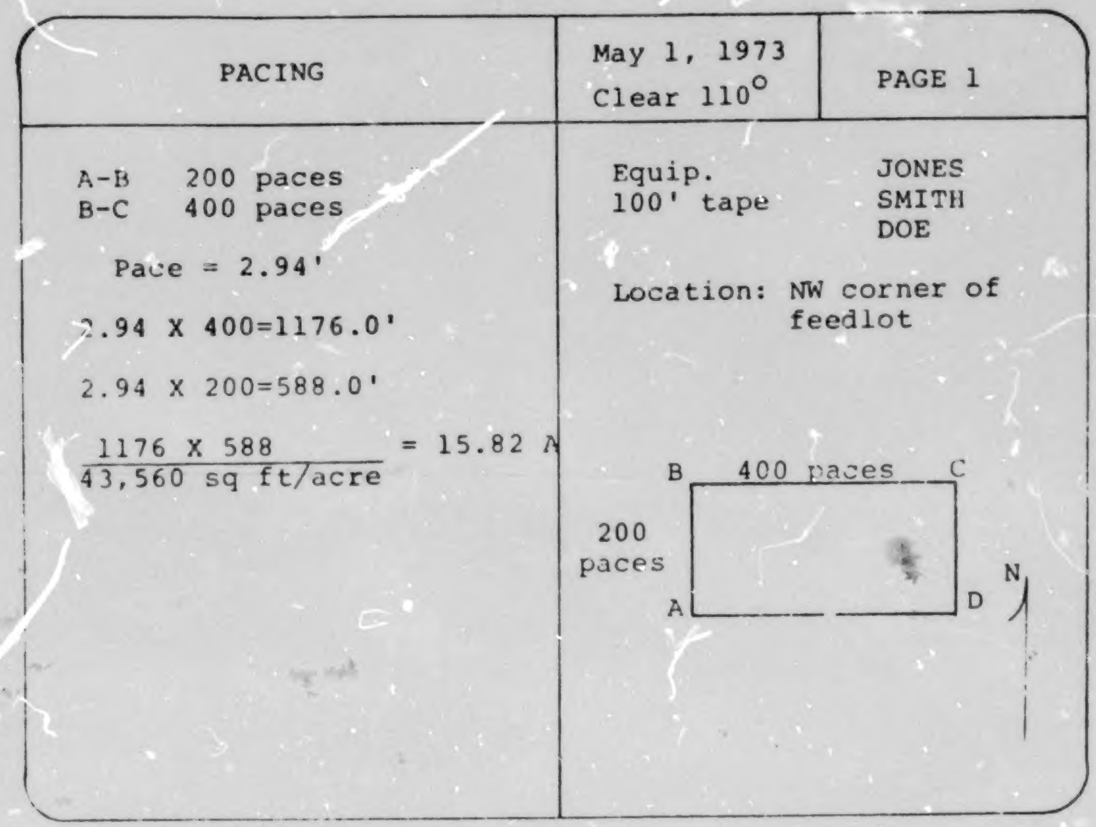
Each double page thereafter is numbered one through the number of pages needed. The left side of the double page at top center should describe the type of exercise attempted. Below this, the information obtained during the survey and all calculations is presented. The right side of the double page in the upper right hand corner should list the page number. On the first line, upper left hand corner, should be the date, below this, the weather and temperature. In the right hand corner below the page number, should be the crew members' names. Below the temperature on the left side of the page should be a list of the equipment used, location of the survey, and a map of the area surveyed. The direction "north" should be indicated on the map. (Figure 3-13)

INDEX	Page
PACING	1
PROFILE LEVELING	2
DIFFERENTIAL LEVELING	3
CUTS & FILLS	4

Fig. 3-12

The Steel Tape

In agricultural production practices acreages need to be known for government acreage allotments and per acre cost calculations. Knowing the crop acreage is also useful when purchasing fertilizer, pesticides, etc. Many agriculturalists use the steel tape to determine acreage. This is probably the most accurate method of measuring horizontal distances.



PACING	May 1, 1973 Clear 110°	PAGE 1

A-B 200 paces
B-C 400 paces

Pace = 2.94'

2.94 X 400=1176.0'

2.94 X 200=588.0'

$$\frac{1176 \text{ X } 588}{43{,}560 \text{ sq ft/acre}} = 15.82 \text{ A}$$

Equip.	JONES
100' tape	SMITH
	DOE

Location: NW corner of feedlot

B
400 paces
C
200 paces
A
D
N

Fig. 3-13

Chaining (Taping) Procedure:

The chaining operation using a steel tape should follow a standard procedure to reduce potential errors. First the head chainman goes forward and sets the range pole for "lining-in" purposes. Meanwhile, the rear chainman "throws" the tape by laying it out in the general direction of the line to be measured, being careful that it is not looped or twisted. The head chainman then takes the zero marked end of the tape and moves forward pulling the tape toward the first range pole. When the 100 foot marked end of the tape nears the first pin, the rear chainman calls out "chain". At this signal, the head chainman halts and quickly places himself in a straight line with the range pole aided by left or right signals from the rear chainman.

As soon as the tape has been placed on line, the rear chainman holds the 100 ft. mark exactly even with the pin. The head chainman takes his position just to the left of the line (not on the line), kneels, and applies approximately 10-12 pounds of tension to the tape with his left arm bearing against his leg. His right hand is then free to place the pin on line and at the zero mark of the tape. When the head chainman sets his pin, he should be assured that the rear chainman is holding his end of the tape accurately on the mark. Also the rear chainman must not pull his pin until the head chainman has finished setting his pin. A system of communication is needed. Therefore, before setting his pin, the head chainman waits for the signal "right here" from the rear chainman. As soon as he has set the pin, the head chainman also calls out "right here". This is also the signal for the rear chainman to pull his pin. It is important that the signals be carefully coordinated.

At the initial starting point (generally marked by a transit stake) the head chainman holds a ring containing eleven pins. The head chainman sets the first pin adjacent to the stake. He then proceeds with the zero end and lays out 100 feet of tape in the direction to be measured and places the second pin at the 0 ft. mark of the properly tensioned tape. On command the rear chainman pulls the first pin to indicate that one tape length has been measured. When the head chainman sets the third pin, the rear chainman pulls his second pin. This confirms that two tape lengths have been measured. When the head chainman sets his eleventh or last pin, he calls out "tally". The rear chainman now has ten pins which he brings forward so that the chaining process can be continued. The number of "tallies" recorded will be the number of thousands of feet which have been measured.

If the end of the line being measured is a previously fixed point, the last measurement will nearly always be a fractional tape length. It is here that mistakes in chaining most frequently occur. To avoid confusion the following systematic procedure is recommended when using a tape which has an additional foot marked in tenths extending beyond the zero end. (See Figure 2-14b)

When the end of the land distance to be measured is reached, the head chainman halts and the rear chainman moves to the last pin where he quickly adjusts the tape so that an even foot mark is aligned with the pin. This is done so that the head chainman's end of the tape will fall within the section of the tape which is subdivided into tenths. Tension is then applied, and the head chainman reads the number of tenths, estimating hundredths, if necessary, which is in alignment with the pin. At the same time the rear chainman identifies the number of the foot mark which is opposite the pin. The tenths which the head chainman reads is added to the number the rear chainman reads, to obtain the measured distance. For example, the head chainman reads 0.28 ft. as that part of the tape which extends beyond the 0 ft. mark and the pin alignment point. Because the rear chainman had previously set the tape at the 35 ft. graduation, the head chainman then calls out "add twenty-eight hundredths"; the rear chainman calls out "thirty-five" and they both make the addition mentally and check each other on the result, which is determined to be 35.28 ft. If, in addition, the rear chainman should carry seven (7) pins on his ring, (he does not count the one in the ground), the total distance measured would be 735.28 feet.

If the tape is marked as illustrated in Figure 2-14b, the tenth reading is subtracted from the rear chainman's reading. In the above illustration, assume the head chainman reads 0.28 ft. This figure would be subtracted from 35 ft. to obtain a measured distance of 34.72 ft.

If the chaining is done on a hard surface, such as a sidewalk, steel rail, or pavement, the position of the end of the tape is marked with a piece of colored lumber crayon or kiel. The number of the tape length is recorded beside the mark as a means of keeping the count of tape lengths measured. To avoid mistakes, the rear chainman calls out the number of his mark just before the head chainman records the next number.

Taping on Sloping Ground:

The procedure for measuring with a steel tape on sloping ground is the same as on level land areas except that after the chain has been laid out its entire length by the head chainman, he returns to a point selected by the rear chainman. When moving up hill, the rear chainman, with the aid of the hand level or by estimation, will hold the chain about chest high at a point along the chain. The head chainman will hold the chain at this point on the ground surface. With the aid of a plumb bob, the rear chainman will hold his end of the chain directly over the starting points. (Figure 3-14) If the head chainman is going downhill the procedure is reversed.

Pins are used at each breaking point of the chain. However, the pins are not counted the same as on level ground. Instead, a record is kept of each distance taped until the 100 foot point cumulative is reached, then the 100 foot interval is recorded.

When distances are measured on the ground surfaces which are sloping in comparison to using the level tape technique, a correction must be added to the surface distance to secure the true horizontal distance. For each 100 ft. of a known percent slope a correction of $\frac{S^2}{200}$ / 100 ft. is added

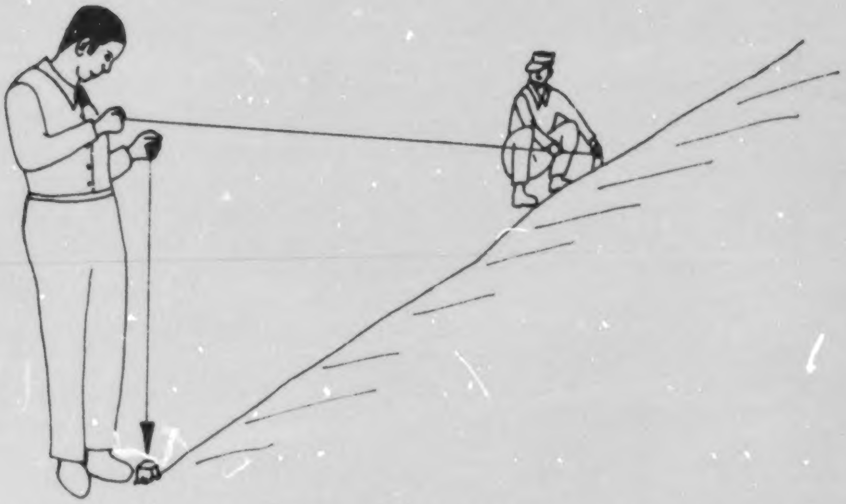


Fig. 3-14. Chaining on Sloping Ground - The rear chainman holds the tape about chest high and with the use of a plumb bob will hold the tape directly over the starting point.

(S = percent of slope). For example, if the slope were 10 percent and the distance measured was 300 ft., the correction would be computed as follows:

$$\frac{S^2}{200} /100' = \frac{(10)^2}{200} \times \frac{300}{100} = \frac{100}{200} \times \frac{300}{100} = 1.33 \text{ ft.}$$

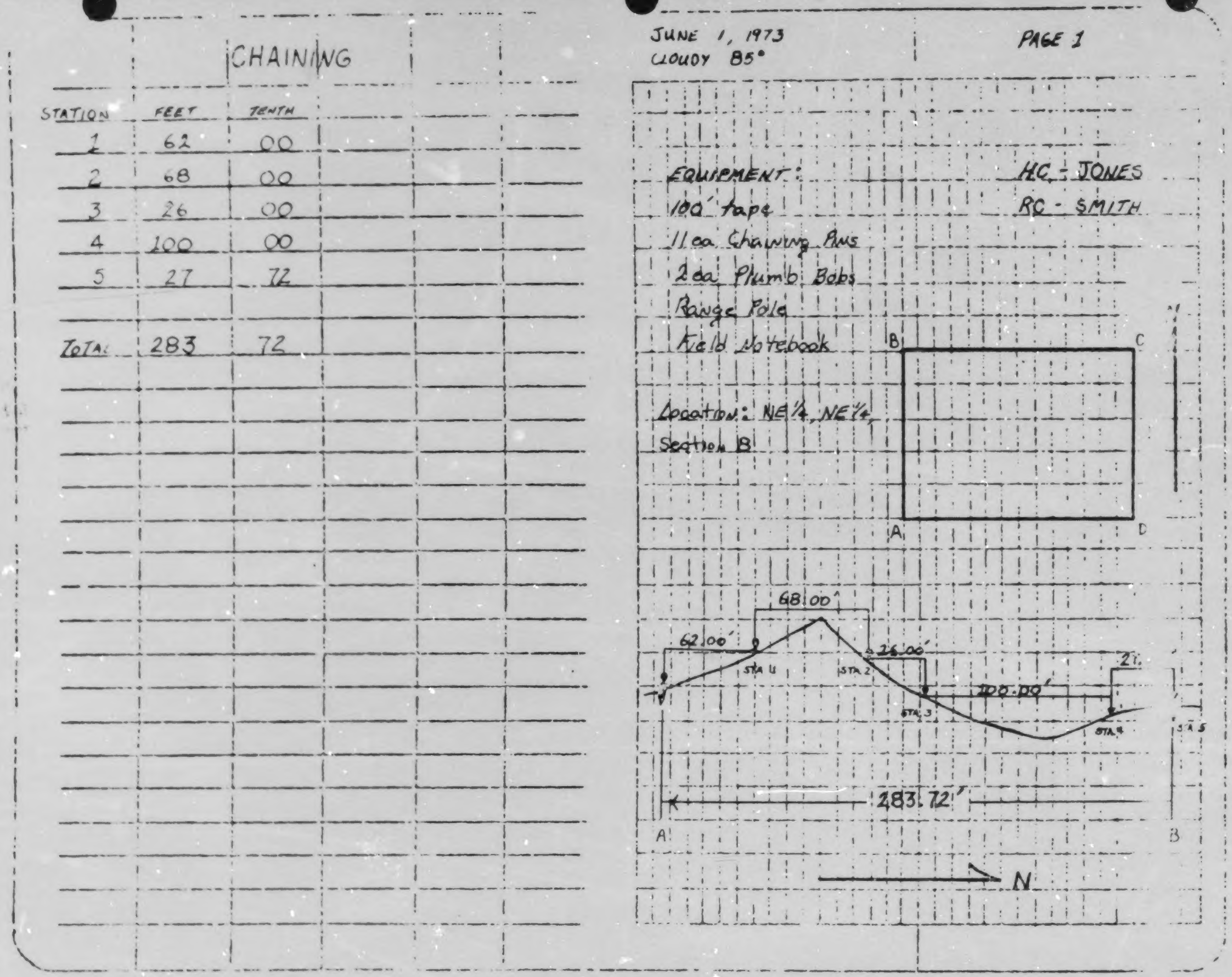
300 ft. + 1.33 ft. = 301.33 ft. = correct lineal distance measured

A set of field notes for breaking chain is illustrated in Figure 3-15.

Errors in Measurement:

Errors in measurement include:

1. Tape not pulled tight enough.
2. Tape not in proper alignment.
3. Pins not carefully placed at proper marks on tape.
4. Mistakes in counting pins.
5. Mistakes in determining number of feet less than 100 feet. This happens when using the fractional length at the end of the tape.
6. Plumb bob not used when measuring on a slope.
7. Wrong points on the tape used for zero or the 100 foot mark.
8. Reading or recording the wrong numbers.



CHAINING

STATION	FEET	TENTH
1	62	00
2	68	00
3	26	00
4	100	00
5	27	72
TOTAL	283	72

JUNE 1, 1973
CLOUDY 85°

PAGE 1

EQUIPMENT:
100' tape
11 ea Chaining Pins
2 ea Plumb Bobs
Range Pole
Field Notebook

HC - JONES
RC - SMITH

Location: NE¼, NE¼,
Section 8

B
C
A
D
68.00'
62.00'
26.00'
27.
100.00'
STA 1
STA 2
STA 3
STA 4
STA 5
283.72'
A
B
N

Fig. [illegible]. Field Notes for Breaking Chain

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Measuring Horizontal Distances With a Level

The telescope tube of some levels contain 3 horizontal cross hairs (Figure 3-16). The top and bottom cross hairs are called stadia hairs and may be used to measure horizontal distances. The stadia hairs are usually spaced so that when the stadia hairs align with a one foot interval between them the rod is being held 100 feet from the tube. (Figure 3-17)

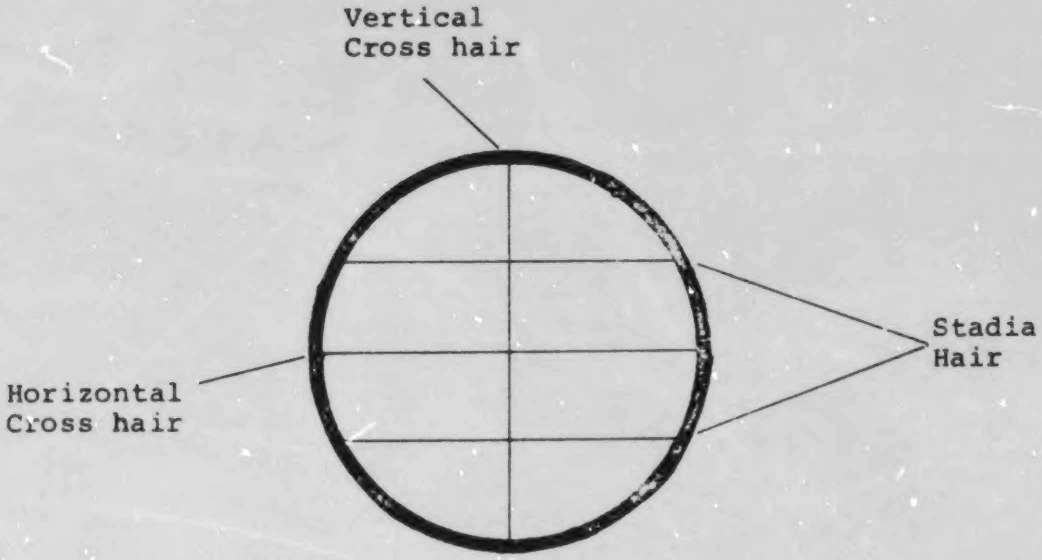
Vertical
Cross hair
Stadia
Hair
Horizontal
Cross hair

Fig. 3-16. Looking through the telescope tube you will see three horizontal cross hairs.

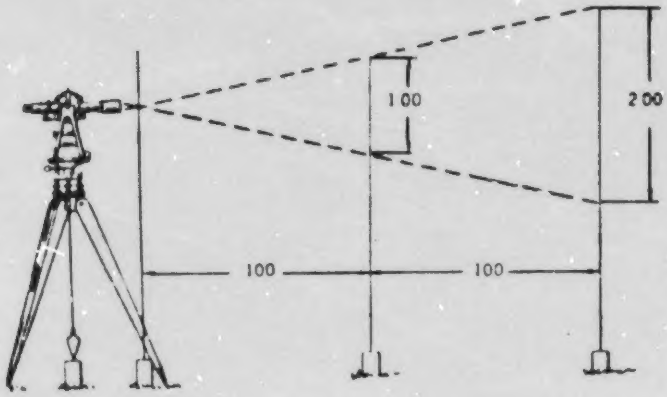
100
200
100
100

Fig. 3-17. Each foot intercepted on the rod represents a distance of 100 feet.

Figure 3-18 further illustrates the measurement of distance using stadia. The instrument man reads 1.89 ft. with the top stadia hair and 1.21 ft. with the bottom stadia hair. The difference in readings times 100 equals a horizontal distance of 68 feet.

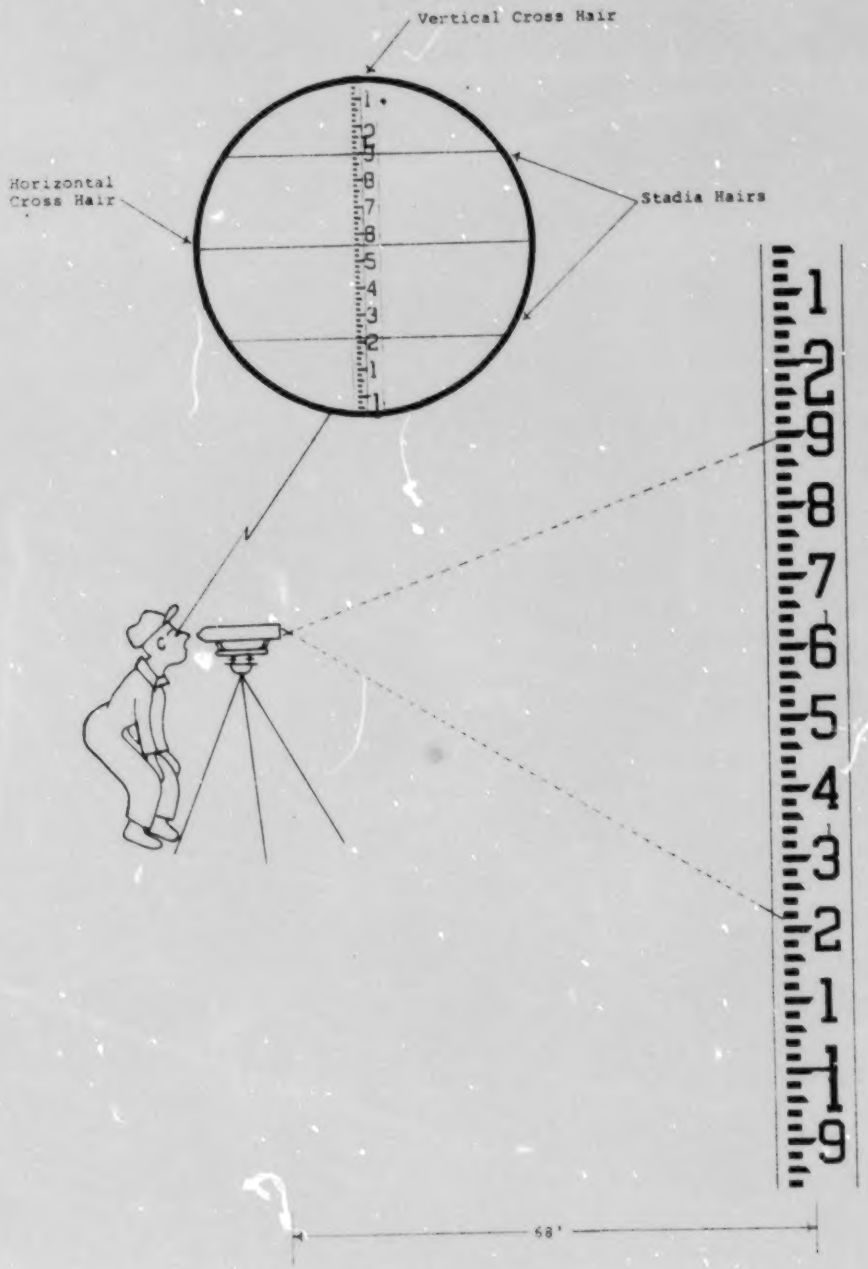
Vertical Cross Hair
Horizontal Cross Hair
Stadia Hairs
68'

Fig. 3-18. Measuring horizontal distances using the stadia.

Land Measurement by Use of Aerial Maps

With the use of aerial maps similar to the one in Figure 3-19 agriculturalists can measure land distances and determine acreages. Mechanical, direct reading map measures simplify measurements of straight or curved lines on aerial maps. (See Figure 3-20) The map measurer is simple to use. The indicator is set at zero and the line to be measured is traced with the tracing wheel as the instrument is lightly hand-held like a pencil. The hands of the instrument will indicate the length of the line in feet and inches (1/8 inch or 1/10 inch). The map measurer is self correcting. The length of an incorrectly traced line is subtracted simply by "back tracing".

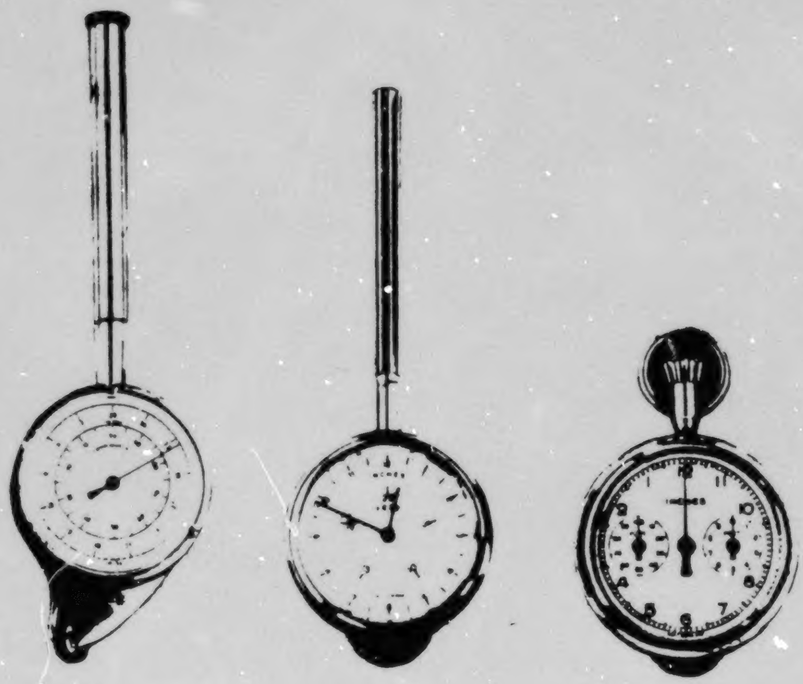

Fig. 3-20. A wide variety of map measurers are available, offering a broad range of measuring units.

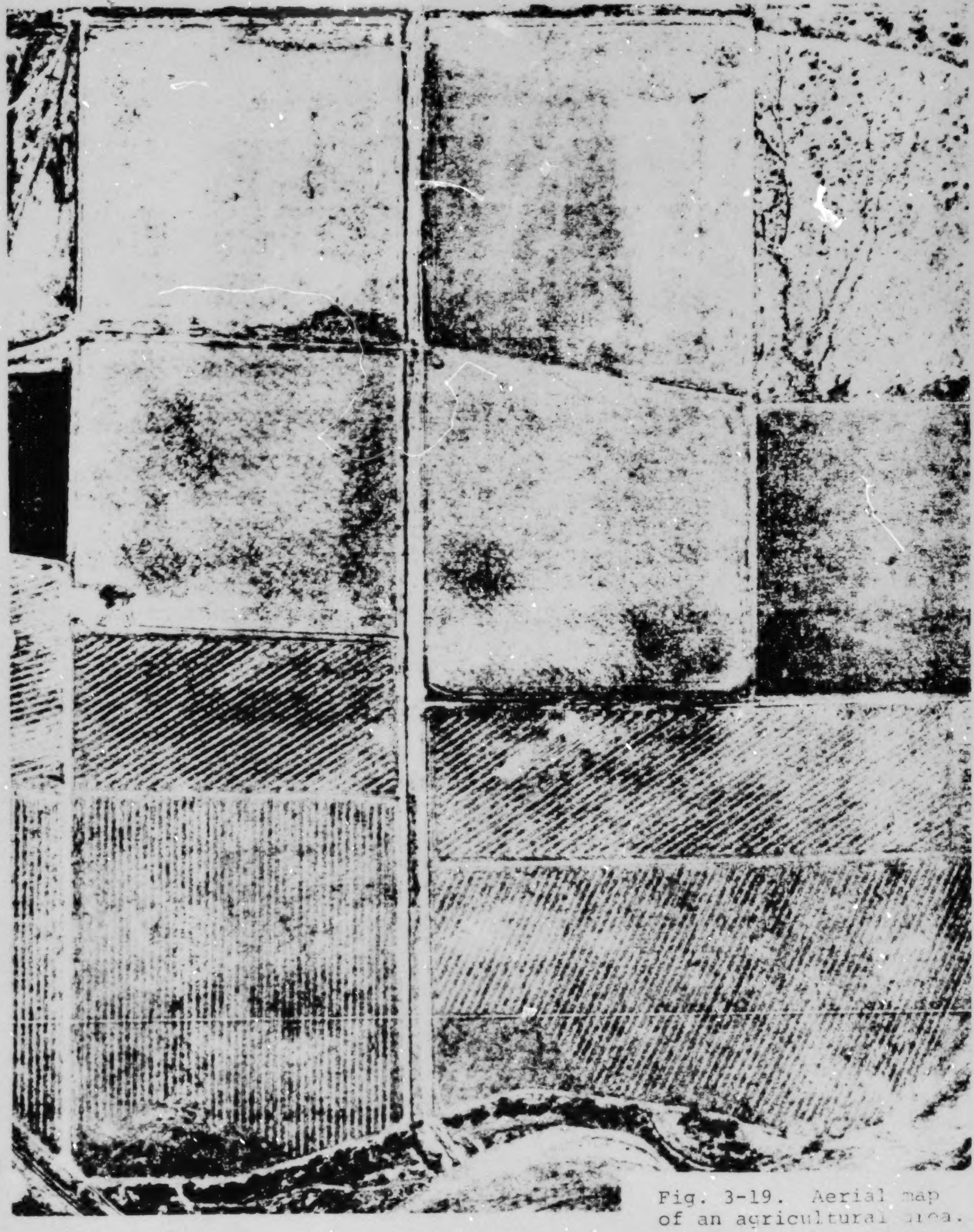

Fig. 3-19. Aerial map of an agricultural area.

Scale: 1 inch = 400 feet

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If a map measurer is not available, an agriculturist can determine distances on aerial maps with the use of a sheet of paper and an engineer's scale. To do this, lay the edge of the paper on the map next to the line to be measured. If the line is straight, mark the beginning and ending of the line on the edge of the paper. Using the correct "scale" on the engineer's scale determine the distance of the measured line. It should be noted here that the "scale" used on the engineer's scale should coincide with that of the aerial map. To measure a curved line the curve should be broken into short straight lines as shown in Figure 3-21.

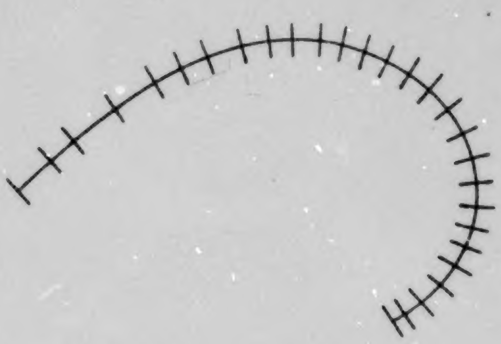

Fig. 3-21. To measure the length of a curved line it must be broken into many small straight lines.

Unit 4

LEVELING OPERATIONS

The basic function of the tripod level is to provide the operator of the instrument with a level line of sight in a 360 degree horizontal plane. It is from this line of sight specific elevation of land surfaces can be determined. A wide variety of agricultural related land use tasks require that elevation or changes in elevation be known before production or construction activities can be successfully accomplished. It is the purpose of this unit to describe the process and procedures to perform several commonly used leveling operations.

Differential Leveling

Differential leveling is the process of determining the difference in elevation between points. The starting point may be an official bench mark elevation or it may be a point to which an arbitrary value of elevation is assigned. Figure 4-1 illustrates a typical differential level. It makes use of an assumed bench mark with an arbitrarily assigned elevation of 100.00 feet. The object is to determine the elevation of a new point.

Procedure:

The procedure used to accomplish the differential level illustrated in Figure 4-1 is as follows:

1. The instrument man notes that the elevation of the bench mark is established at 100.00 feet.

2. The instrument man sets up and levels the instrument a suitable distance away from the bench mark in the direction toward the new point (Point A). Sighting distance should not be so great as to make it impossible to read the rod accurately. Maximum distance for most levels and for good accuracy is 150 to 200 feet. Longer shots may be taken depending upon the degree of accuracy required.

3. The instrument man makes a backsight reading of 3.60 feet on the rod which is held plumb on the bench mark by the rodman. After taking the reading, the instrument man checks the bubble again to assure himself that it remained centered while he was taking the reading.

4. The reading is entered in his notes in the BS column. To obtain the height of instrument, (HI) the BS reading is added to the bench mark elevation of

100.0 feet. He then enters the value of 103.60 feet in the HI column. He gives the "all right" signal which the rodman recognizes as his cue to move to a new point along the route of survey.

5. The rodman moves the rod toward Point A, the maximum distance limited by the accuracy required and the change in elevation limits due to rod length. He places the rod on a solid spot on the ground making sure that the front face of the rod is plainly visible to the instrument man.

6. The instrument man aligns the telescope toward the rod, focuses and checks to see that the level bubble is centered. He takes a foresight reading of 2.10 feet on the rod and rechecks the level bubble. Entering the reading in his notes he subtracts 2.10 feet from the height of instrument, and obtains an elevation of 101.50 feet for the first rod position which is identified as TP_1. In differential leveling, the rodman must remember that each new setting of the rod will be a turning point and the signal....."take a turning point", is unnecessary.

7. The rodman holds the rod on TP_1 while the instrument man makes a new setup in the direction of Point A and takes a backsight of TP_1 to get the new height of instrument.

8. Steps 2 through 7 are repeated until Point A is reached and its elevation relative to the bench mark is obtained. The experienced instrument man usually will not make his calculations in the field, as described above. He will have his note keeping procedure well enough organized that he can spend his field time taking readings and entering them properly in his notes. The calculations can then be made at any later time. For the beginner, it is advised that he make the calculations as he goes comparing each new height of instrument and elevation against his own estimate of what it should be. This procedure can be very helpful in avoiding needless mistakes such as reading the wrong foot mark on the rod. It also helps all members of the party to form a visual image of their immediate progress and accomplishments.

Field Notes for Differential Leveling:

It is suggested that the field notes for leveling of this type be kept in five columns. Figure 4-2 shows a set of notes kept in a manner that has been found to help the beginner visualize his procedure and catch errors in entering notes. The typewritten figures are readings taken in the field. The handwritten figures are computations made from the readings. A plus sign (+) is entered in the heading of the BS column because BACK SIGHT IS ALWAYS ADDED TO ELEVATION TO FIND HEIGHT OF INSTRUMENT. A negative sign (-) appears in the FS column because THE FS IS ALWAYS SUBTRACTED FROM H.I. TO FIND ELEVATION.

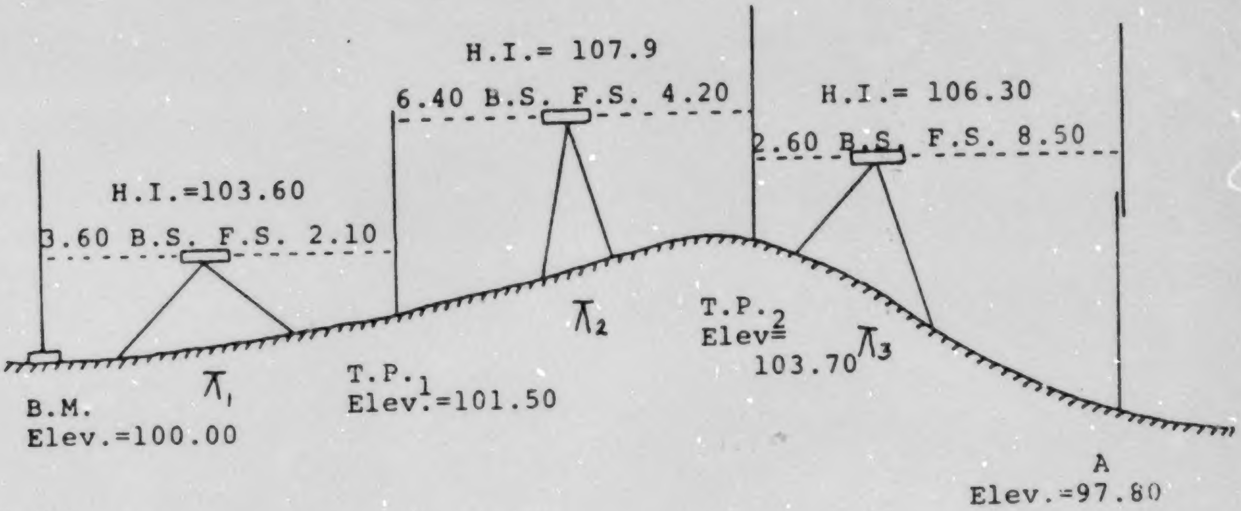
H.I.= 107.9
6.40 B.S. F.S. 4.20
H.I.= 106.30
2.60 B.S. F.S. 8.50
H.I.=103.60
3.60 B.S. F.S. 2.10
$\bar{\Lambda}_2$
T.P.₂
Elev= 103.70
$\bar{\Lambda}_3$
$\bar{\Lambda}_1$
T.P.₁
Elev.=101.50
B.M.
Elev.=100.00
A
Elev.=97.80

Fig. 4-1. Differential Level

STA.	B.S.(+)	H.I.	F.S.(-)	ELEV.	REMARKS
BM	3.60 →			100.00	
$\bar{\Lambda}_1$		103.60 →			
TP_1	6.40 →		2.10 →	101.50	
$\bar{\Lambda}_2$		107.90 →			
TP_2	2.60 →		4.20 →	103.70	
$\bar{\Lambda}_3$		106.30 →			
A			8.50 →	97.80	

Fig. 4-2. Field notes for Differential Leveling of Figure 4-1.

Go back through the previously described procedure and fit it to the set of notes in Figure 4-2. Take particular note of the following:

Since the first BS is taken on the BM, the reading (3.60), is entered on the BM line, BS column. The next line is identified with the symbol $\overline{\wedge}_1$ to indicate instrument height (103.60) set-up number one. Since the next sight is a foresight on TP_1, it is entered on a new line labeled TP_1 and in the FS column (2.10). When the elevation of TP_1 is calculated, it is also entered on this same line (101.50). The next sight after the instrument is moved is a BS taken on TP_1 so that reading is also entered on the line, TP_1 - in the BS column (6.40). From here on the notes repeat in successive steps until the job is completed. When a separate line is used for each HI, then a properly entered set of notes follows a pattern on the page represented by the arrows in Figure 4-2. It is often advisable to use the notebook sheet opposite the notes for a rough map of the route and for remarks to help recall the work completed for future reference.

After some experience is gained in keeping notes, it may be desirable to eliminate the extra line used for the height of instrument. A condensed set of notes of the previous leveling operation appears in Figure 4-3.

STA.	B.S.(+)	H.I.	F.S.(-)	ELEV.
BM	3.60	103.60		100.00
TP_1	6.40	107.90	2.10	101.50
TP_2	2.60	106.30	4.20	103.70
A			8.50	97.80

Fig. 4-3. Condensed form of notes for differential leveling.

Checking the Calculations:

It may be noted from Figure 4-3 that the difference in elevation between the first and the last point is equal to the sum of all the backsights minus the sum of all the foresights. If the result is negative (the sum of the foresight is the greater) then the final point is lower than the beginning elevation. This procedure may be used as a check on the accuracy of the arithmetic when the longer forms of notes are employed.

Profile Leveling

Profile leveling is the process of determining the elevation of a series of points along a given line. If for example, the cross-section profile of a drainage ditch were to be plotted, the elevation might be obtained at 50 foot intervals along the route. Profile leveling is essential to layout and constructing drains, roads, dams, waterways, and similar structures.

Procedure:

The procedure for profile leveling is very similar to that for differential leveling. The principle difference is that each point upon which a reading is taken is not called a turning point (TP) but a station, and exact distances between points are recorded. The method of recording distances is to identify the successive 100 foot intervals. For example, 0+00 indicates the starting point; 1+00 for 100 feet, 2+00 for 200 feet, etc. Intermediate points such as 150 feet from the starting points are recorded as 1+50; the distance of 235 feet is recorded as 2+35. In addition to the regular intervals, readings are taken at each sharp change in land surface and the distance noted in the conventional manner.

To survey for profile, the area in question is first "stationed", i.e., marked off at intervals of 100 or 50 feet depending upon the job requirements. The level is set up and a backsight taken on a bench mark to establish the height of instrument. Foresights are then taken on as many station points on the line convenient to the position of the instrument.

When it is necessary to move the level to a new position in order to take readings on stations ahead, a turning point is selected and its elevation determined. The turning point may or may not be a station on the line depending upon the choice of the party chief. The level is then taken forward and the new height of instrument determined by taking a backsight on the turning point. This procedure is repeated until the end of the line is reached.

A line of levels should be checked when possible by connecting with some reliable bench mark. If bench marks are available along the line of levels, they should be used as turning points or at least to check readings. When sighting on such points, the reading taken on the bench mark is really a foresight since its elevation will be determined from the height of instrument.

It is a good plan to select turning points that are permanent enough to be used should more than one profile level be required of the area.

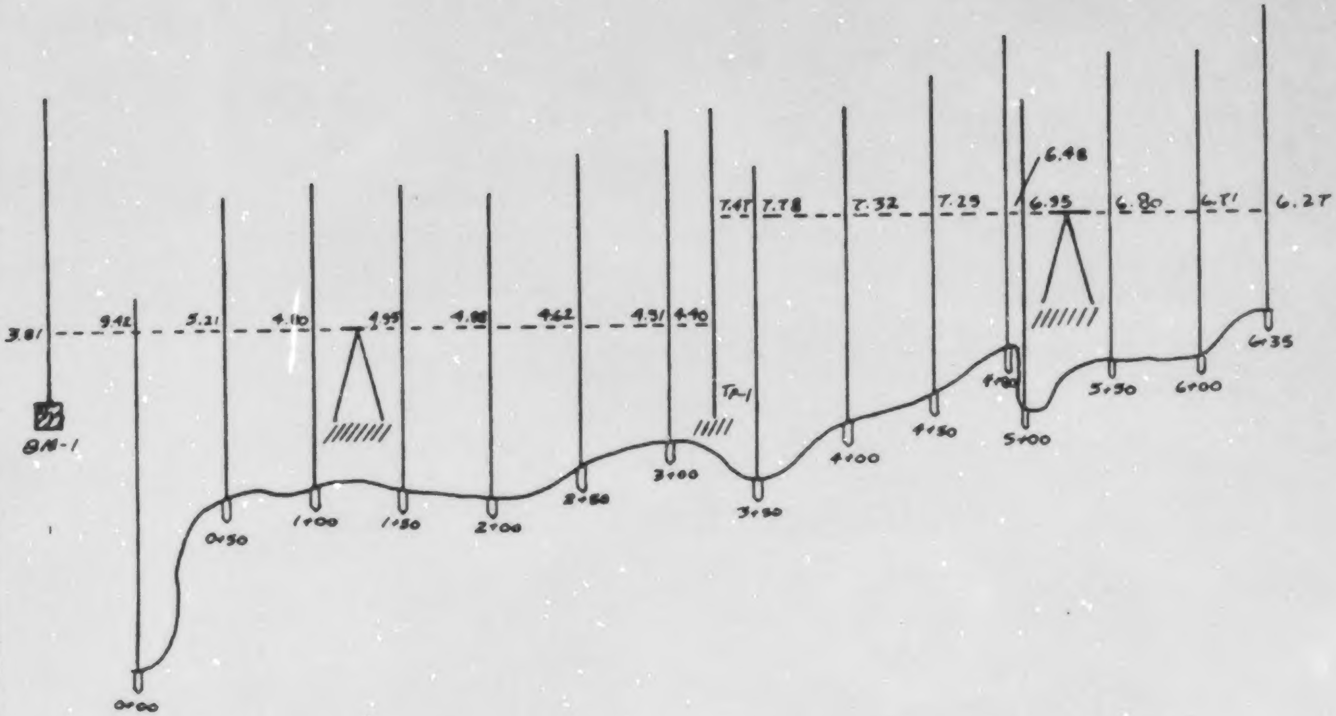
3.81
9.42
5.21
4.10
4.95
4.88
4.62
4.31
4.40
7.47
7.78
7.32
7.25
6.48
6.95
6.80
6.71
6.27
BM-1
TP-1
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00
4+50
4+80
5+00
5+50
6+00
6+35

Fig. 4-4. Profile Leveling Operation

PROFILE LEVELING

FOR DRAIN TILE ON R. SMITH FARM

STATIO	BS	HI	FS	ELEV.
BM	3.81			100.00
		103.81		
0+0			9.42	94.39
0+5			5.21	98.60
1+0			4.80	99.01
1+5			4.95	98.86
2+0			4.98	98.83
2+5			4.62	99.19
3+00			4.51	99.30
TP	7.47		4.40	99.41
		106.88		
3+5			7.78	99.10
4+0			7.32	99.56
4+5			7.25	99.63
4+8			6.48	100.40
5+			6.95	99.83
5+5			6.80	100.08
6+0			6.71	100.17
6+3			6.27	100.61
TP-			6.81	100.07
		107.38		
BM			7.39	99.99
		ERROR =	0.01'	

August 12, 1973
Hot, Clear Calm

R. BROWN ⊼
K. GREEN ϕ

TOP NE CORNER CONCRETE HEADWALL AT
SW CORNER OF FARM
IN DITCH, 20' EAST OF BM-1

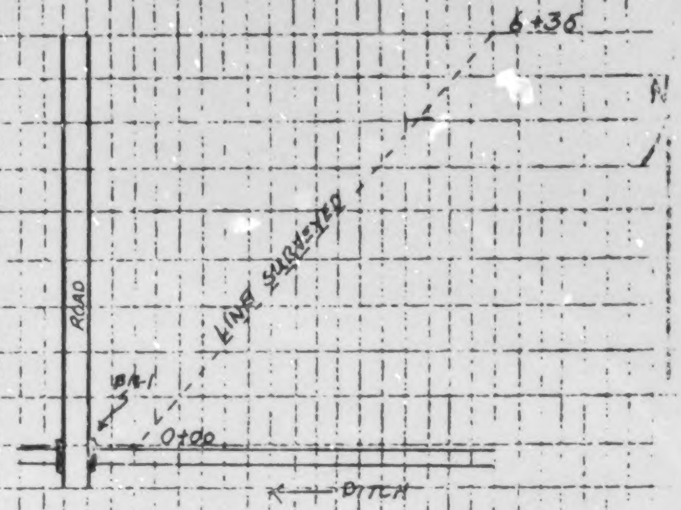

Fig. 4-5 Field Notes for Profile Leveling

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Figures 4-4 and 4-5 show a profile leveling operation and the field notes for a tile drain over a 635 foot course. Readings were taken at regular 50-foot intervals with two intermediate locations, at 4+80 and 6+35. Intermediate readings are taken at unusually high or low spots, or in this case at the end of the leveling course.

Contour Mapping

Contour mapping is a valuable tool to identify land drainage patterns in order to plan cropping systems, reduce soil and moisture losses and increase crop production. Contour maps are also used in landscape and building layout planning.

Contour Defined:

A contour is an imaginary line connecting points having the same elevation. The shore line of a body of water is perhaps the best visible example of a contour.

Contour Interval:

A contour interval is the vertical distance, or difference in elevation, between two adjacent contours (Figure 4-6).

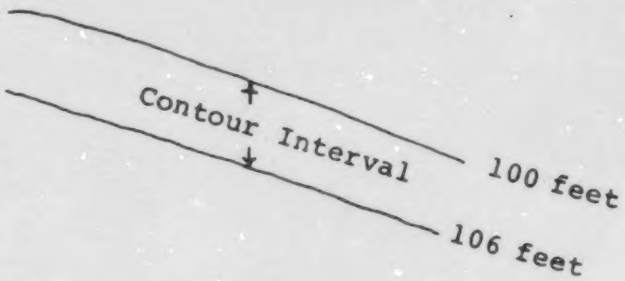
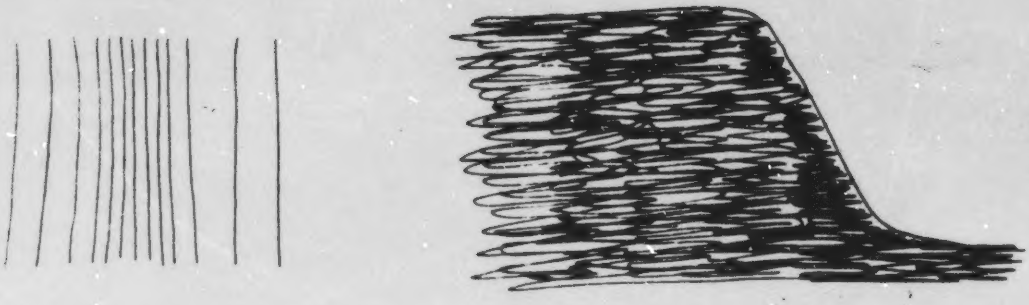


Fig. 4-6. An illustration of two contour lines having a contour interval of 6 feet.

Contour Lines:

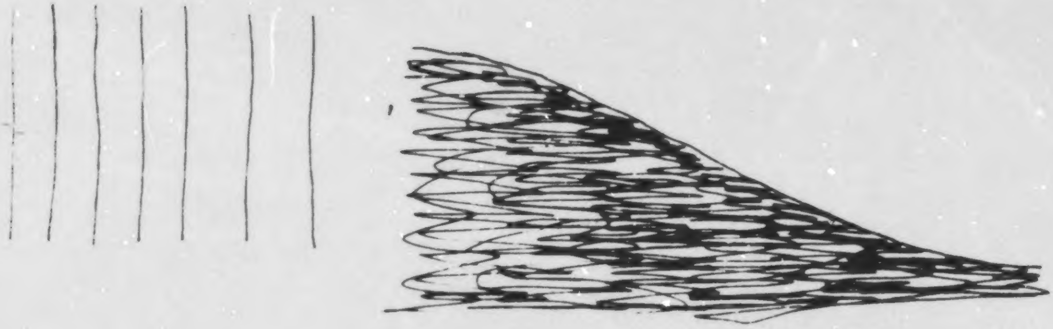
A contour line on a map is used to describe and represent a ground surface having the same elevation. Contour lines on a map or plot which are spaced closely together represent a surface having a steep slope. If the lines are spaced further apart, they represent a more gentle slope assuming the same measurement scale is used. (Figure 4-7 and 4-8)



As seen on a map
Contour Lines

As seen on the ground
Slope

Fig. 4-7. Contour lines close together represent a steep slope.

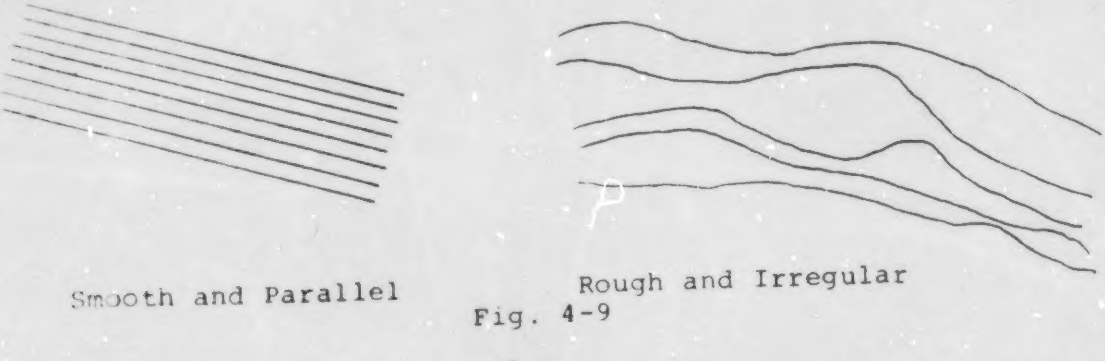


As seen on a map
Contour Lines

As seen on the ground
Slope

Fig. 4-8. Contour lines spaced well apart represent a gentle slope.

If the ground surface is rough and uneven, the contour lines will illustrate this irregularity on the map; if the ground surface is even, as on earthwork slopes, the contour lines will be uniform and parallel. (Figure 4-9)



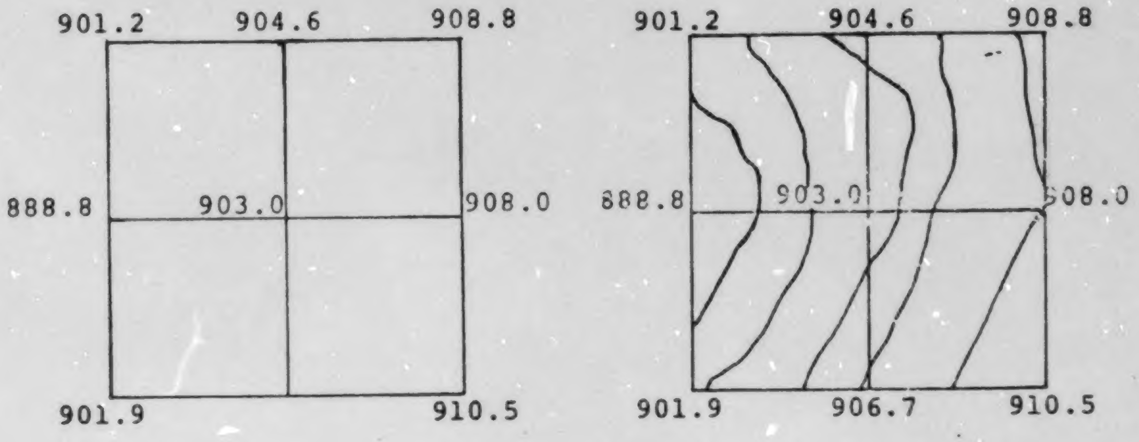
Smooth and Parallel

Rough and Irregular

Fig. 4-9

Contour Mapping:

Contour mapping can be accomplished using a basic and widely used system. It involves establishing a grid of squares, marked by a series of stakes on the ground surface. The elevation of the ground at each stake is determined so that contour lines may be drawn with reference to known elevations. (Figure 4-10)


901.2
904.6
908.8
888.8
903.0
908.0
901.9
910.5
901.2
904.6
908.8
888.8
903.0
908.0
901.9
906.7
910.5

System of squares with deviations of the corner.

Contour lines drawn in.

Fig. 4-10

Mapping Procedure:

The mapping procedure for developing a contour map is as follows:

Step I. The land area to be mapped should be laid out in a grid pattern. Establish an east-west line and a north-south baseline as near as possible to two boundaries of the field or area to be contour mapped. (Figure 4-11)

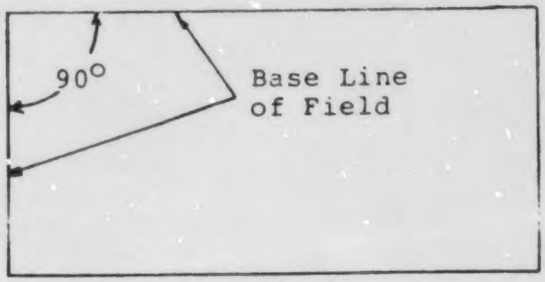

90°
Base Line of Field

Fig. 4-11. Establishing baselines.

Step II. Starting from the corner where the two base lines meet, measure with a steel tape at 100 foot intervals along the base lines. Drive tall stakes into the ground at each 100 foot interval. These intervals should be marked as shown in Figure 4-12.

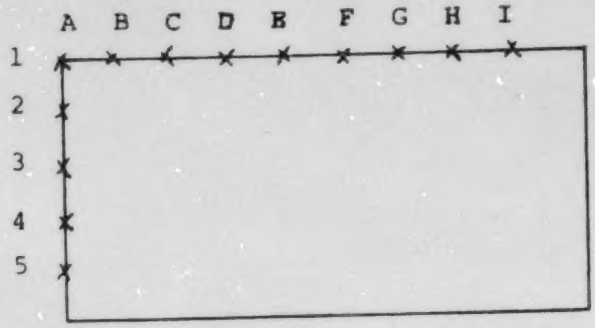

A
B
C
D
E
F
G
H
I
1
2
3
4
5

Fig. 4-12. Marking 100 foot intervals along each baseline.

Step III. Another line of stakes should be driven one grid interval distance (100 feet) from each baseline (Figure 4-13). From these points it is possible for the rodman to "sight-in" his position from any point by aligning the appropriate pair of stakes. (Figure 4-14)

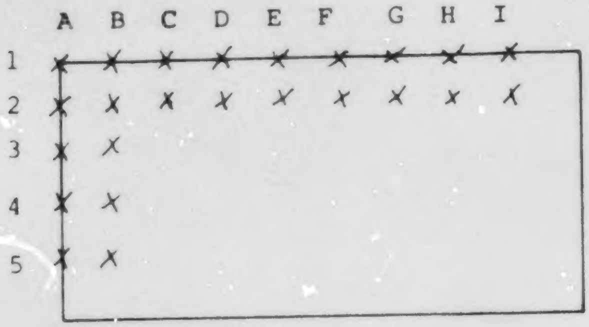

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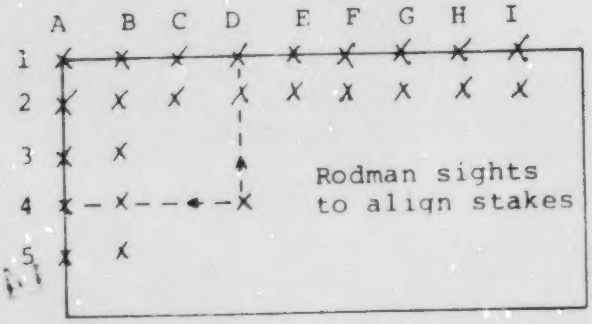
Fig. 4-13


A
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I
1
2
3
4
5
Rodman sights to align stakes

Fig. 4-14

Step IV. Set up the leveling instrument somewhere in the field where the entire field can be seen through the telescope tube.

Step V. Take a backsight on a bench mark, some other point of known elevation, or a sight on a permanent object which is then given an arbitrary elevation of 100.0 feet. (Figure 4-15)

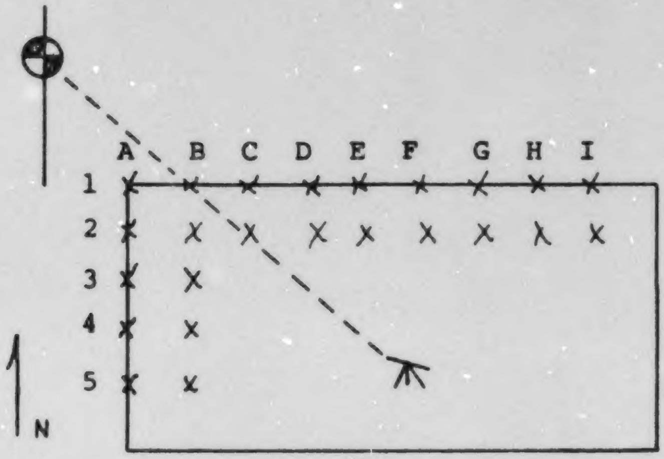


Fig. 4-15. Taking a Backsight.

Step VI. With a grid system located on the ground, the elevations of the various points are determined by profile leveling. Points are identified in the field notes by lettering each grid point on the east-west base line and numbering each grid point on the north-south base line. Each grid point then is identified by a combination of one letter and one number that corresponds to its location on the map. (Figure 4-16 and 4-17)

Step VII. To draw the contour map, reproduce the grids on ten square graph paper. The scale should conform to one of those found on an engineer's scale. Show the elevation of each grid point on the map. Contour lines are usually given values in even numbers. They will therefore seldom pass directly through a grid point of observed elevation. The location of the contour lines is determined by interpolation between adjacent grid points. (Figure 4-18)

Examples of Field Notes For Grid System

STATION	BACKSIGHT	INSTRUMENT HEIGHT	FORESIGHT	ELEVATION	REMARKS
BM	1.00	101.0		100.0	Pipe NW corner
A-1		101.0	4.5	96.5	
A-2			3.7	97.3	
A-3			3.2	97.8	
B-1			5.0	95.0	
B-2			4.2	95.8	
B-3			3.0	97.0	
C-1			7.0	93.0	
C-2			5.5	94.5	
C-3			3.9	96.1	
D-1			4.6	95.4	
D-2			5.8	94.2	
D-3			2.8	97.2	

Fig. 4-16

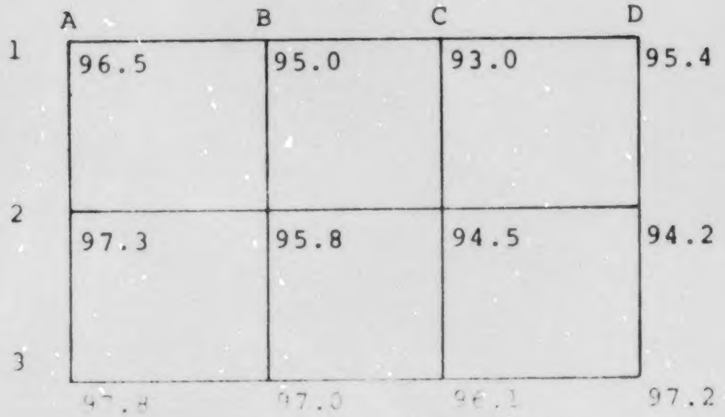

A
B
C
D
1
2
3
96.5
95.0
93.0
95.4
97.3
95.8
94.5
94.2
97.8
97.0
96.1
97.2

Fig. 4-17

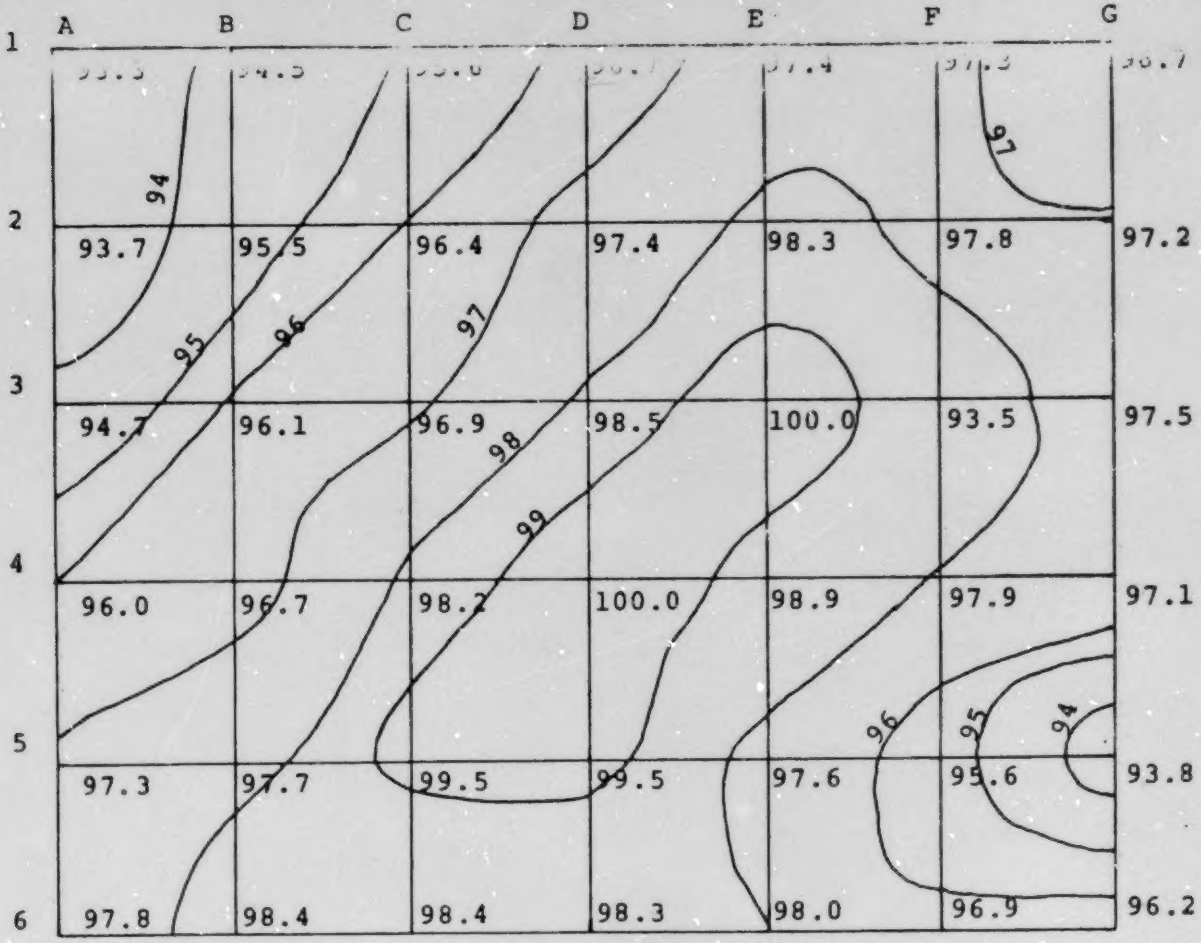

A
B
C
D
E
F
G
1
2
3
4
5
6
93.7
95.5
96.4
97.4
98.3
97.8
97.2
94.7
96.1
96.9
98.5
100.0
93.5
97.5
96.0
96.7
98.2
100.0
98.9
97.9
97.1
97.3
97.7
99.5
99.5
97.6
95.6
93.8
97.8
98.4
98.4
98.3
98.0
96.9
96.2
94
95
96
97
98
99
97
96
95
94

Fig. 4-18. Drawing in the contour lines.

Grades, Cuts and Fills

Land leveling operations require the use of soil moving machinery to remove material from points of high elevation and deposit it in low spots. The operation is called "cut and fill". Generally this operation is performed so that the completed land area is constructed to a specific degree of slope or grade for drainage or movement of water across a field at a desired rate.

Grades:

Grade is defined as the ascending or descending land surface compared to a level line of sight. It is commonly referred to as the slope of the ground. For example, if a field rises 1 foot in 100 feet the grade equals 1/100 or 1 percent. If the parcel of land should descend or drop 1 foot in 100 feet the slope or grade is still 1 percent, but is a negative slope. Slope can also be expressed foot per foot instead of percent. For example, a slope of .001 ft/ft. would indicate one foot fall in 1000 feet.

Cuts and Fills:

The vertical depth of soil that must be removed or added to make the ground surface conform to a prescribed grade or slope is referred to as cut or fill. For example, if the elevation of a field is 10 feet at a prescribed location and the land grading plan calls for an elevation of 8.5 feet at that point, a cut of 1.5 feet is required. Conversely if the elevation of the field at the point is 6.0 feet and the land grading plan calls for 8.5 feet elevation, a fill of 2.5 feet is required. Figure 4-19 shows a profile with cuts and fills.

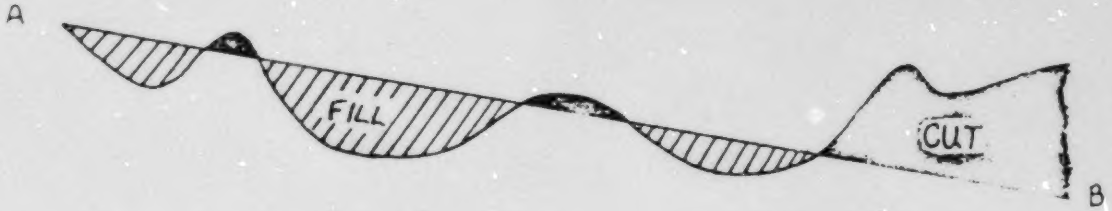


Fig. 4-19. Line AB represents the desired grade or slope of the parcel of land. Any portion of the contour line above the grade line AB is a cut; any portion of the contour line below the grade line AB is a fill. Earth must be removed from the cuts and placed in the fills to make the field level or meet the desired slope or grade.

If a parcel of land is improperly graded or an error is made in the calculation of a cut or fill, the grade or slope of the field may not be uniform. If the field is furrow irrigated, this uneven grade of slope may cause a backup of water in low areas. (Figure 4-20) When water stands in low areas for some period of time, the possibility of soil compaction, leaching of soil nutrients and lower crop production in that area of the field is increased.

A field that is properly leveled or graded will have a uniform distribution of water when irrigated. (Figure 4-21)

Grading Procedure:

1. Clear the field of all vegetation.

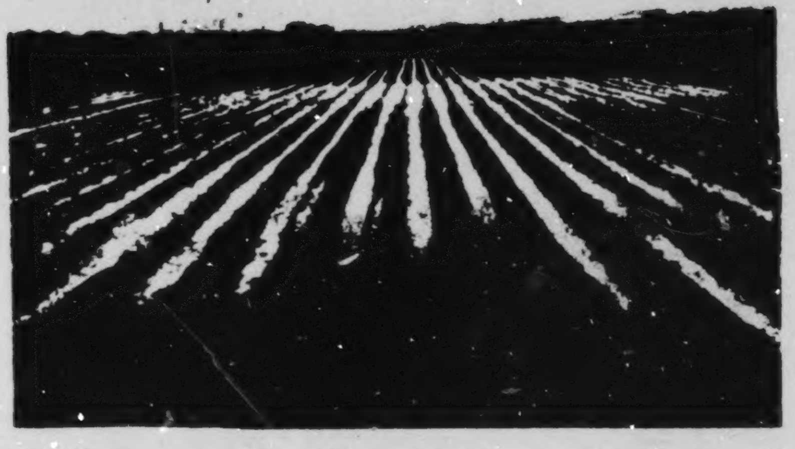
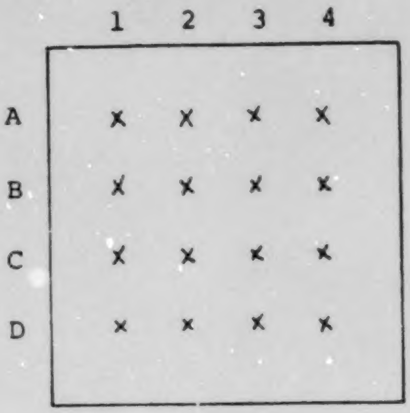


Fig. 4-20. Low area in field caused by improper grading or an error in the calculation of a cut or fill.

Fig. 4-21. A bordered field showing even distribution of water when the grading job is well done.

2. Lay out a contour development grid on the field. The usual grid spacing is 100 feet in each direction; a 50 x 50 foot spacing can be used, but it requires four times as many stakes to set, shoot, plot, compute and mark.

x = stakes placed at each station. Distance or interval between stakes is equal to 100 feet.



3. Determine the ground elevation of each station (stake). Set up the leveling instrument where the entire field can be seen through the telescope tube. A backsight is taken on a bench mark or some other point of known elevation. If there is no point of known elevation, take a sighting on a permanent object and give it an arbitrary elevation of 100.0 feet.

4. Once the rod readings are taken the elevation of each station must be determined. This is done by subtracting the rod reading from the height of instrument. For example, the elevation of station A-1 is computed as follows:

$$\frac{\text{HI}}{9.9} - \frac{\text{Rod Reading}}{3.5} = \frac{\text{Elevation}}{6.4 \text{ feet}}$$

6.4 is entered on the field map as shown in Figure 4-23. The other ground elevations are determined in a similar manner.

5. It has been determined that the method of irrigating the field will be the furrow type. The National Engineering Handbook on irrigation states that the field should have a slope of between .27% and .4%. It is decided that a slope of .4% (a drop of .4 feet for every 100 feet of field) will be used.

6. The next step is to calculate the average elevation of the field. This is done by summing all the elevations and dividing by the number of elevations. In this case the average elevation is equal to:

$$\frac{90}{16} = 5.6 \text{ feet}$$

This average elevation is placed in the center of the map as in Figure 4-23.

7. The grade elevation of each station is now calculated. The interval between stations is 100 feet. The distance from the center station to station B2 is 50 feet north and 50 feet west. We therefore add .2 to the 5.6 elevation of the center station to determine the grade elevation of station B2 (5.6 + .2 = 5.8). The slope is .4 feet per 100 feet but since we are concerned with a distance of 50 feet to station B2 the slope will be half that for 100 feet or .2 feet.

   For stations west of the center, the slope per 100 feet will be added to the elevation of the previous station, and subtracted for those east of the center.

8. Now that the grades at each station have been found, the cuts and fills can be determined. This is done by subtracting the grade and elevation at each station. If the elevation is larger than the grade, the value will be positive or will be a cut. If the elevation is smaller than the grade, the value will be negative and will be a fill. At station B4 for example, the present elevation is 5.4 feet. The desired elevation is 5.8 feet. Consequently a fill of .4 feet is needed at this station. At station A3, the present elevation is 6.5 feet and the desired elevation is 6.2 feet. A cut of .3 feet is necessary. Some stations, such as C2 are at grade and require no cut or fill.

9. The rod reading, elevation, grade elevation, and cut or fill taken at each station is marked on the upper face of each stake as shown in Figure 4-22. These same readings are entered on the surveying map as illustrated in Figure 4-23.

10. It is necessary to have a balance between cut and fill so that for a particular field, the cuts will be enough to fill the stations that are low. Normally an excess of cut over fill in a ratio of approximately 1.2 to 1.6 is allowed because of compaction of the fill and equipment operator errors in fully cutting all areas down to the desired grade.

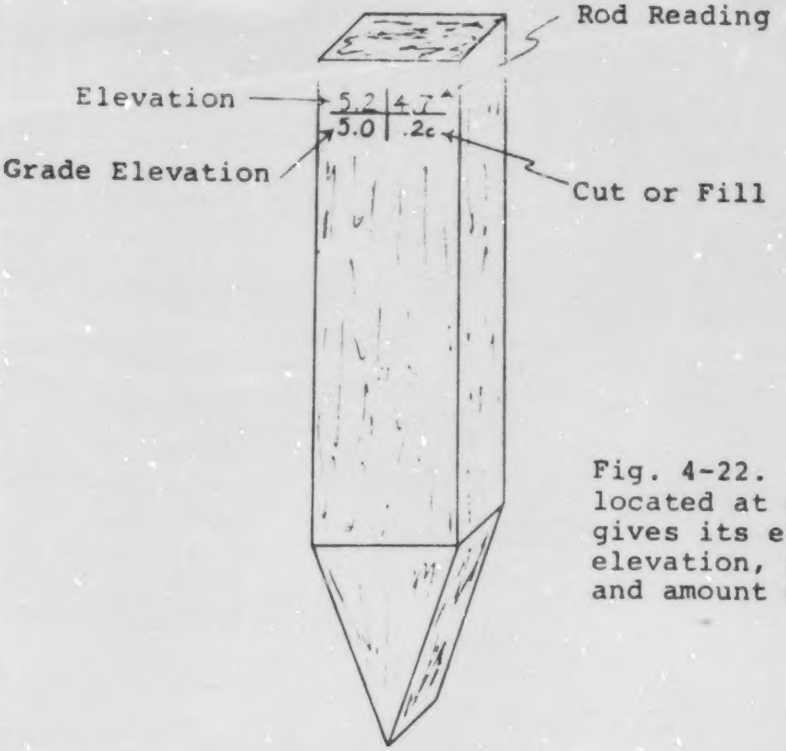


Fig. 4-22. Field stakes located at each station gives its elevation, grade elevation, rod reading, and amount of cut or fill.

To check this ratio, the cuts and fills are summed. In this case the cuts = .2 + .2 + .3 + .1 + .2 + .1 + .1 + .2 + .2 = 1.6.

The fills = .4 + .1 + .4 + .3 = 1.2

The cut/fill ratio is determined by the following formula:

$$\frac{\text{Sum of cuts}}{\text{Sum of fills}} = \text{cut/fill ratio}$$

For the field in Figure 4-22 the ratio is:

$$\frac{1.6}{1.2} = 1.33$$

Since 1.3 is within the range 1.2 - 1.6 there will be enough earth from the cuts to fill the lower areas of the field.

If a satisfactory ratio was not calculated, all grade elevations would have to be lowered by .1 and cuts and fills recalculated.

Information placed on field stake:

Elevation | Rod Reading
Grade Elev. | Cut or Fill

Grade: 4%
Height of Instrument: 9.9

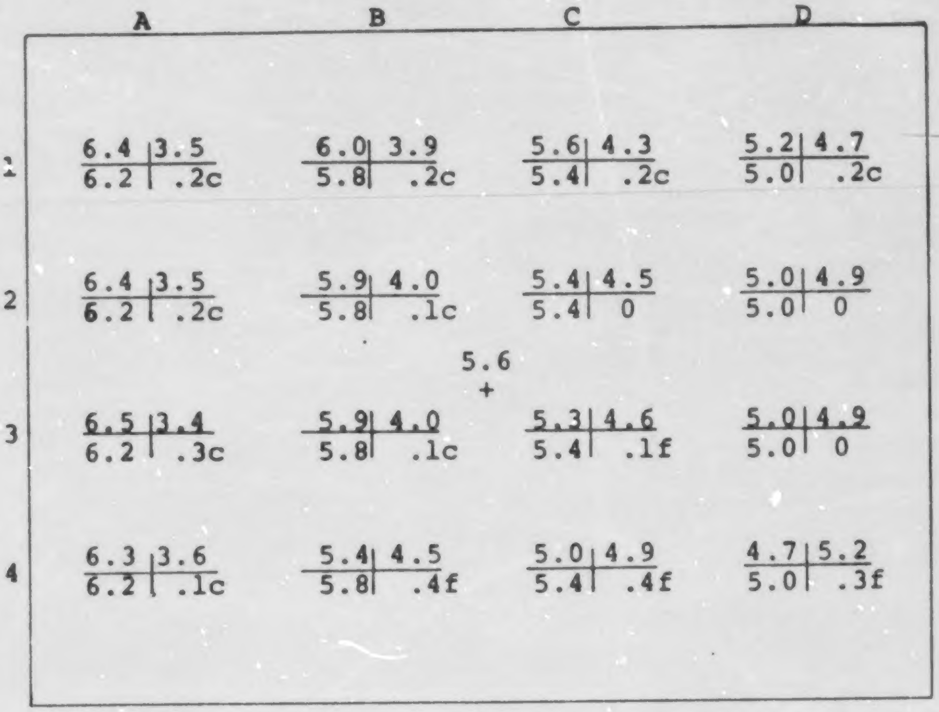

A
B
C
D
1
2
3
4
6.4 3.5
6.2 .2c
6.0 3.9
5.8 .2c
5.6 4.3
5.4 .2c
5.2 4.7
5.0 .2c
6.4 3.5
6.2 .2c
5.9 4.0
5.8 .1c
5.4 4.5
5.4 0
5.0 4.9
5.0 0
5.6
+
6.5 3.4
6.2 .3c
5.9 4.0
5.8 .1c
5.3 4.6
5.4 .1f
5.0 4.9
5.0 0
6.3 3.6
6.2 .1c
5.4 4.5
5.8 .4f
5.0 4.9
5.4 .4f
4.7 5.2
5.0 .3f

Fig. 4-23. Map of a field showing each station and its elevation, grade elevation, rod reading, and amount of cut or fill. Grid interval is equal to 100 feet. Drawing is not to scale.

11. The total number of cubic yards of dirt to be moved in order to level the field can now be calculated. Since each grid is 100 x 100 feet, the cubic yards to be cut is equal to:

$$\frac{1.33 \text{ ft} \times 100 \text{ ft} \times 100 \text{ ft.}}{27 \text{ yds/ft}^3} = 492.6 \text{ cu. yd.}$$

Land Leveling Machinery:

Heavy agricultural earth moving operations are usually performed with tractor drawn scrapers or carryalls similar to the one shown in Figure 4-24. These carryalls vary in design, but all are mechanically operated for loading and

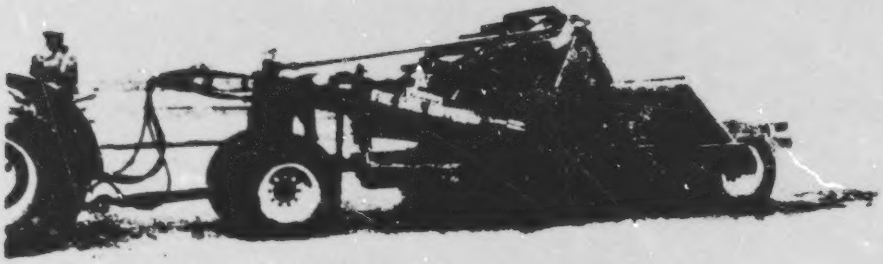


Fig. 4-24. Carryalls are commonly used in agricultural land leveling operations.

(Courtesy of the Farmhand Company)

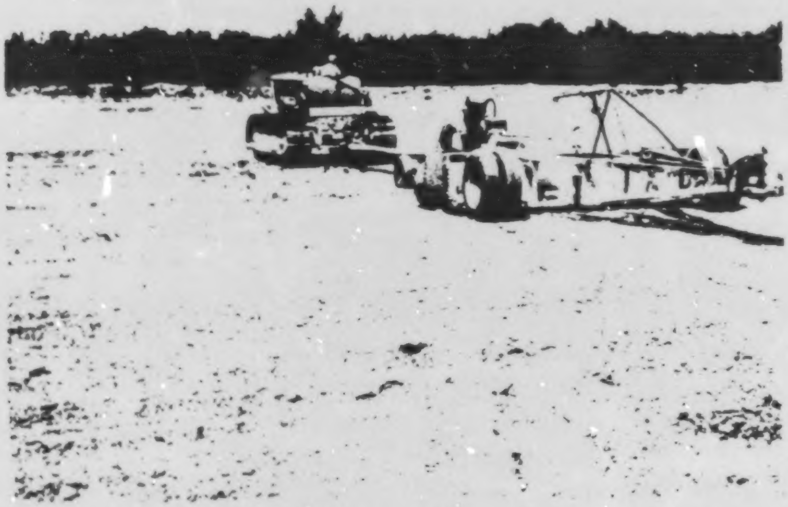


Fig. 4-25. Land planing with a bottomless scraper

unloading. It is not possible to finish land surfaces to the exact grade with the carryall unless very skilled equipment operators are employed.

A bottomless scraper with a long frame is designed to provide a level land surface. It is manufactured in lengths up to 80 feet and widths up to 15 feet. The blade is attached to the frame midway of its length at a height which is adjustable. It is mounted on swivel wheels to make it less unwieldy to turn . When in use the blade is permanently set at a level which will maintain about one-third of a load in the bowl. With this adjustment properly made the machine will, as it is drawn across a field, automatically remove high spots and fill depressions of a diameter equal to nearly one-half its length. Obviously the longest machine available will perform the best. It is customary to take care of the final finishing work with a machine of this type by scraping in three directions -- in each of the two diagonal directions and in the direction of irrigation. The operation is termed land planing.

After the first cropping practice settling will occur in fill areas of the field. Additional planing will be required to provide even water distribution. See Figure 4-20 and 4-21.

APPENDIX A

LAYING A FOUNDATION

Introduction:

There is more to constructing a good foundation than knowing the correct footing size and selecting a suitable wall material. The building must be laid out, the excavation dug, the drainage tile installed and the foundation walls waterproofed. This operation describes how to lay out a building foundation using the tripod level.

Procedure:

Step I The first step in laying out a building foundation is to clear the site. This involves the removal of sod and tree stumps from the immediate area. Vegetation will harbor termites and should not be used for fill or left under the building.

Step II Establish minimum grade of foundation. The ground on which the foundation is to be placed should be graded to provide drainage without excessive slope.

Step III Locate the property corner stakes.

1. Drive a stake into the ground at one corner of the intended foundation (Stake A). If the ground is sloping, place the stake at the highest elevation. If the ground area is near level, any of the four corners will do as a starting point.
2. Measure off the correct distance along one side of the foundation and place a second stake at that point (Stake B), on a line which parallels established buildings, fences and/or roads. Locate the center of the tops of the stakes by drawing 2 diagonal lines across the top. Where these diagonal lines intersect is the center of the stake; a nail is then driven part way into the center of the stake.

3. Attach builder's line to the nails in the stake tops. (Figure A-1)

Fig. A-1

4. Position the level directly over Stake A using the plumb bob and sight to Stake B. (Figure A-2)

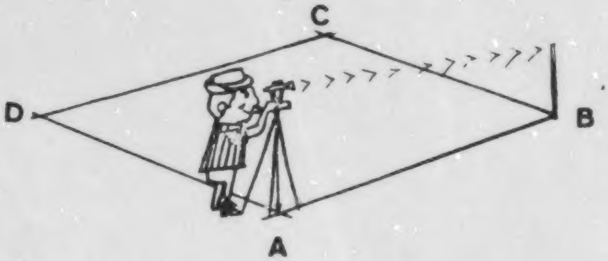
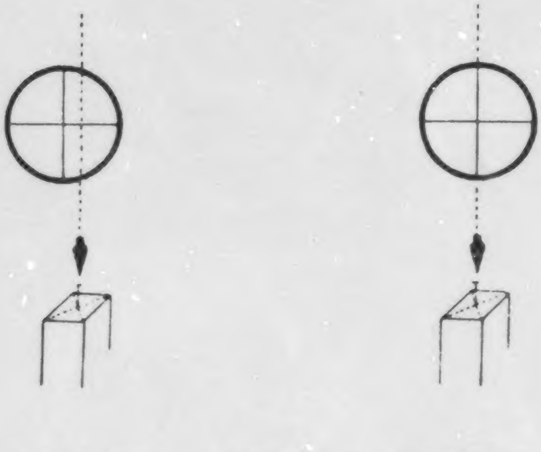


Fig. A-2

Hold the plumb bob over the nail in Stake B and align the vertical cross hair of the level with the plumb bob string. (Figure A-3)



A. Cross hair & plumb bob string out of alignment.

B. Cross hair & plumb bob string in alignment.

Fig. A-3. Aligning the vertical cross hair of the farm level with the plumb bob.

5. When the vertical cross hair of the level is in line with the plumb bob, set the azimuth of the level to 0 degrees.

6. Turn the telescope tube exactly 90 degrees to the left and sight. (Figure A-4) Measure off the correct length of the foundation. Use the plumb bob, aligned with the vertical cross hair to locate Stake D. (Figure A-3) Drive a stake at that position. Locate the center of the stake top and drive a nail into the top at this point. When a line is connected between Stake A and B the outside edge of the foundation will be located. Connect Stake A with Stake D with a builder's line.

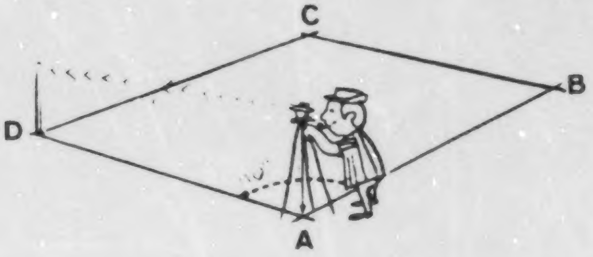


Fig. A-4

7. To determine the location of the fourth corner "C" you will need to measure the distance from Stake B to D. (Figure A-5) Measure the correct length and width of the foundation from Stake B to Stake C, from Stake D to Stake C, and from Stake A to C. Where all three points meet is the location of the fourth corner. (Figure A-6) Place Stake C at this point. Drive a nail in the center of the stake top. Connect a builder's line to the nail in the center of Stake C.

Step IV Right angle batter boards must now be placed on all four corners of the foundation. The batter boards are approximately 6 to 8 feet from the corner stakes and parallel with the foundation walls. (Figure A-7) Right angle batter boards are made by nailing two 1" x 6" to three 2" x 4" stakes. (Figure A-8) The first batter board may be set at any convenient level usually 6" above the surface of the ground and the other three batter board corners made level with it.

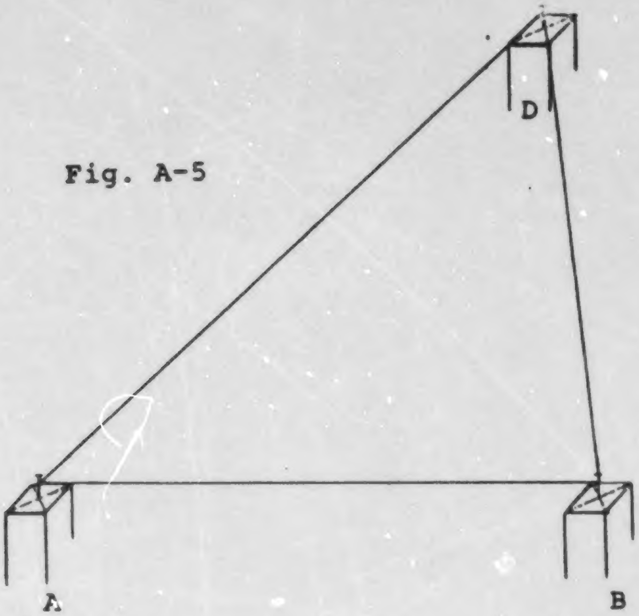


Fig. A-5

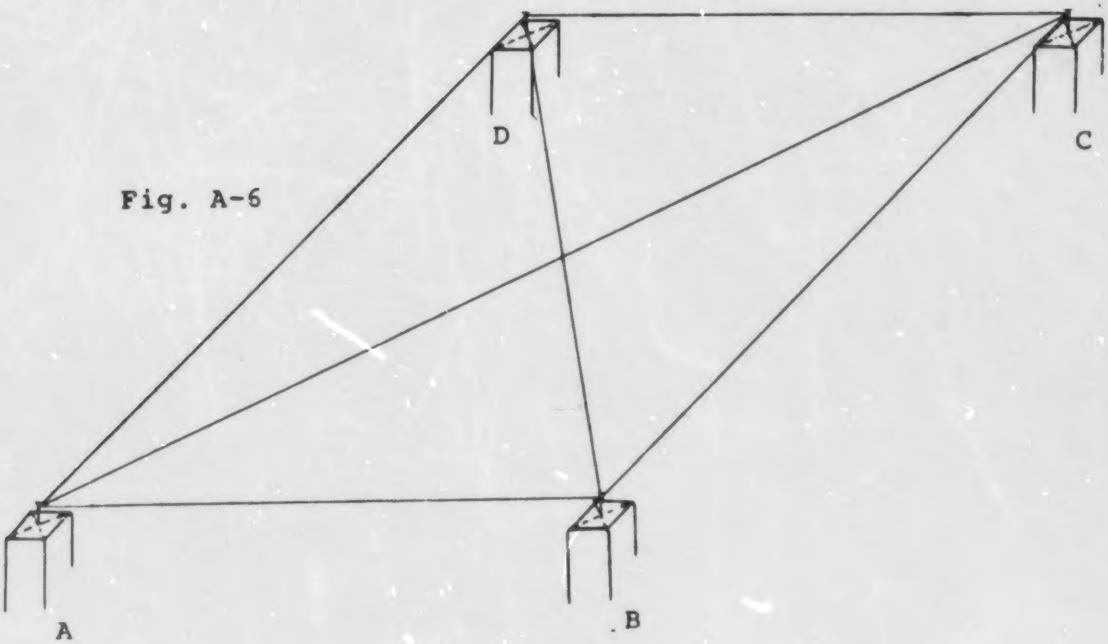


Fig. A-6

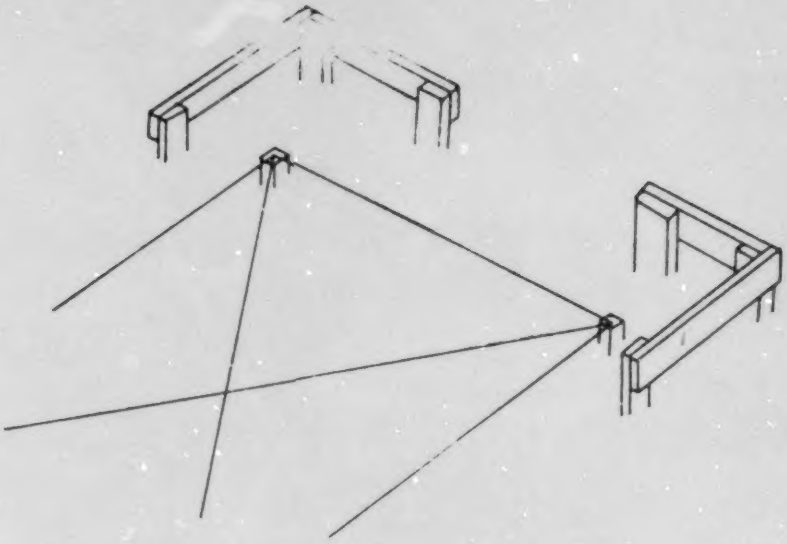


Fig. A-7

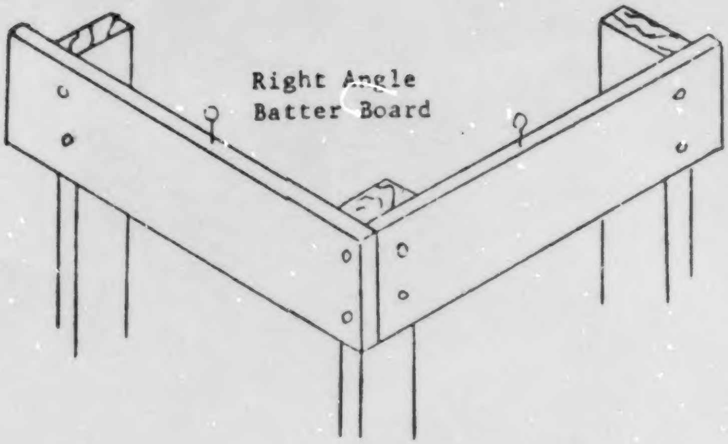


Fig. A-8

The steps to follow in setting the batter boards at the correct elevation are as follows. Assuming that the ground is fairly level, we set up the tripod level in the center of the proposed building area, and locate the position of the batter boards at corner A. A good way to do this is to fasten the batter boards to the stakes at a point slightly higher than the derived elevation and then drive the stakes carefully into the ground to bring the top of the batter boards to the proper height and make them exactly level. This can be determined by taking rod readings on several points on the batter boards as the stakes are being driven. (Figure A-9) The batter boards may be set at the other three corners and leveled in the same manner and to the same elevation as corner A.

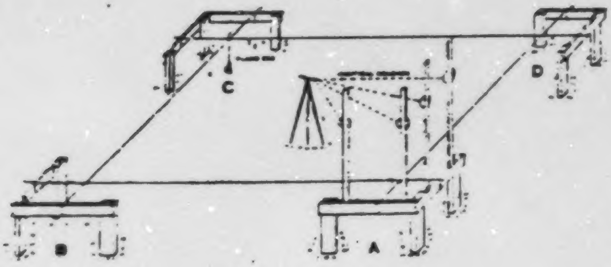


Fig. A-9

Step V. Tie strings on the batter boards to intersect directly over the four corners. Use a plumb bob to locate the intersections of the strings directly above the x marks on the tops of the corner stakes. You may find it useful to mark points of attachment of the strings to the batter boards by making a light saw cut or driving a nail into the batter board. You will then be able to take the string down and put them up again in the correct location after the corner stakes have been removed as the foundation trenches are dug. (Figure A-10).

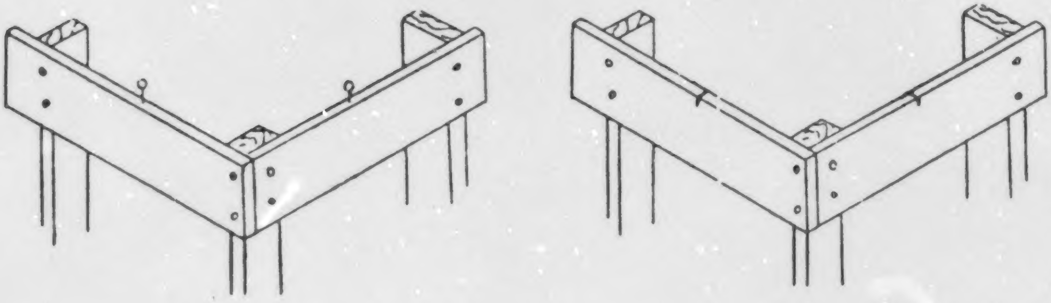


Fig. A-10

APPENDIX B

AgIII-II-90

Field Note Page

APPENDIX C

HAND LEVEL

The hand level, Figure C-1, is used in agricultural leveling for approximate work only.

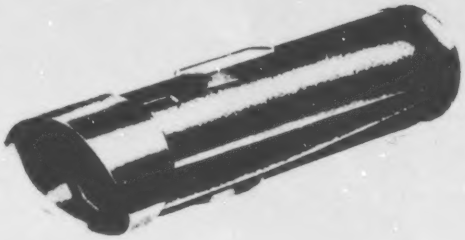


Fig. C-1. Hand Level. Pocket size precision instruments for on-the-job checking and preliminary leveling.

The simplest form of a hand level has no telescope, but is simply a metal tube equipped with a bubble vial, a cross hair at one end, a peep-hole at the other end, and a small mirror inside and in the middle of the metal tube. Figure C-2 shows a cut-away view of a hand level.

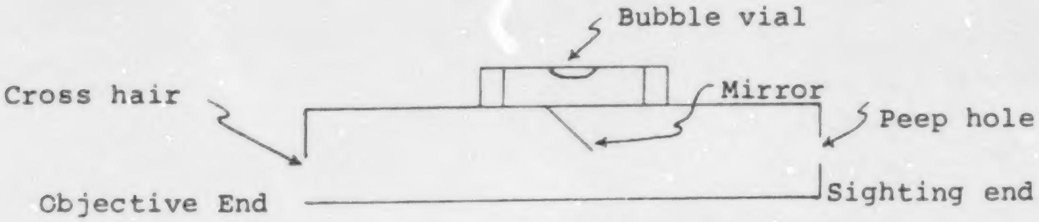


Fig. C-2. Cut-away view of a typical hand level.

The hand level is held in the hand and leveled by raising or lowering the objective end until the cross hair bisects the reflection of the bubble on the mirror. The object sighted and the reflection of the bubble are visible beside each other. (Figure C-3).

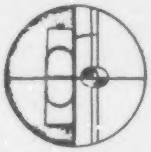


Fig. C-3. View through the hand level showing the appearance of the rod target when it has been placed at the same elevation as the instrument.

Owing to the unsteady support of the hand level, magnification is not helpful and therefore a telescope is seldom incorporated. The levelman can seldom read the rod therefore the target on the rod is used. The rodman adjusts the rod at the direction of the levelman and then reads its position.

APPENDIX D

THE METRIC SYSTEM

Measures of Length:

10 millimeters (mm.)	=	1 centimeter (cm.)
10 centimeters	=	1 decimeter (dm.)
10 decimeters	=	1 meter (m.)
1 meter	=	(39.37 inches (3.28083 feet (1.0936 yards
1 centimeter	=	.3937 inch
1 millimeter	=	(.03837 inch, or (approximately 1/25 inch.
1 kilometer	=	0.62137 mile
10 meters	=	1 dekameter (dm.)
10 dekameters	=	1 hektometer (hm.)
10 hektometers	=	1 kilometer (km.)
1 foot	=	.3048 meter
1 inch	=	(2.54 centimeters (25.4 millimeter

Measures of Surface:

1 square meter	=	(10.764 square feet (1.196 square yards
1 square centimeter	=	.155 square inch
1 square millimeter	=	.00155 square inch
1 square yard	=	.836 square meter
1 square foot	=	.0929 square meter
1 square inch	=	(6.452 square centimeters (645.2 square millimeters

USEFUL NUMBERS IN LEVELING

Distance:

1 mile = 80 chains
320 rods
1760 yards
5280 feet
1 yard = 3 feet
1 rod = 5½ yards
16½ feet
1 chain = 66 feet

Area:

1 square foot = 144 square inches
0.0000023 acre
1 square yard = 9 square feet
1 square rod = 90¼ square yards
1 acre = 10 square chains
160 square rods
4840 square yards
43,560 square feet
6,272,640 square inches
1 square mile = 640 acres
1 section = 640 acres

APPENDIX E

STAKING OUT A FENCE

Introduction:

The instrument best suited for staking out a fence line or setting a series of stakes in line is the transit level. (Figure 2-3, Unit II) The telescope tube on this instrument can be swung in a vertical as well as a horizontal arc. The vertical cross hair is used for lining stakes, while the horizontal cross hair is used for leveling.

Procedure:

Frequently it is desirable to set a new fence line at right angles to an existing fence. To do this, the following procedure should be followed.

1. First set a stake approximately 3 feet from the old fence where the new fence is to begin. Set the transit level over the stake and on line with the new fence.
2. Measure the distance from the old fence to the stake. This distance in Figure E-1 is 3 feet.
3. Move along the old fence line about 20 feet and set a second stake 3 feet out from the old fence line. (Figure E-2) The two stakes are now parallel to the old fence.

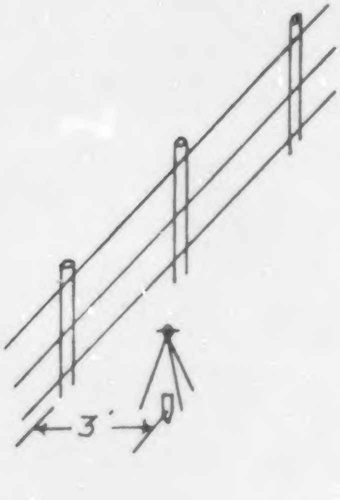


Fig. E-1

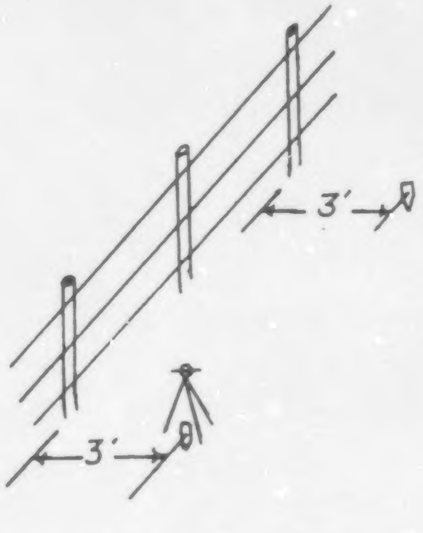
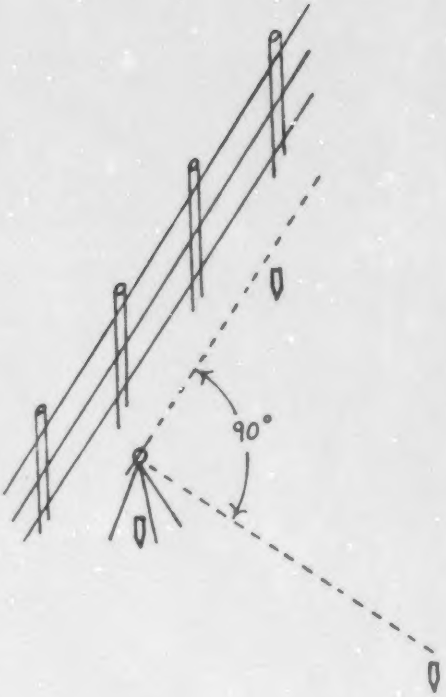


Fig. E-2

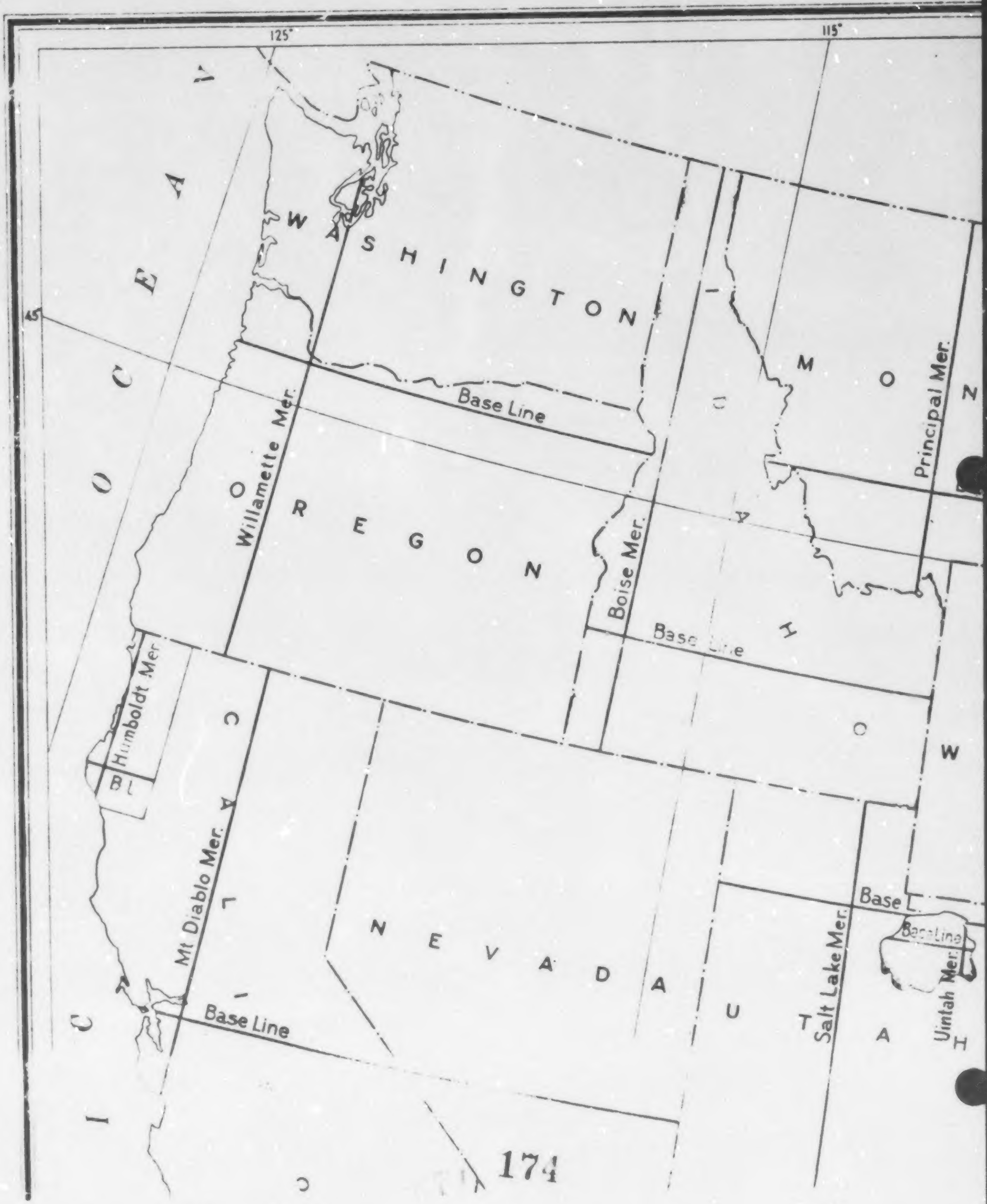
4. Turn the telescope tube and line it up so that the vertical cross hair bisects the second stake and set the azimuth on the horizontal graduated circle to 0°. Then turn the telescope until the indicator on horizontal graduated circle reads 90° pointing down the line of the proposed new fence. (Figure E-3)



5. Set a series of stakes to mark the location of the fence posts using a tape to measure the distances and the telescope to line them up. Tilt the telescope tube and focus it on each location, being careful not to move it away from the 90° setting.

6. After several stakes have been set and the distance becomes so great that the stakes cannot be sighted accurately it will be necessary to move the instrument. Move down the line to the last stake and set up the instrument directly over it so the plumb bob will exactly bisect the stake.

7. Take one sight backward and line the vertical cross hair up on a stake at any convenient distance back. Set the indicator to 0° and turn the telescope tube until it reads 180°. This procedure is continued until the fence has been completely staked out.


125°
115°
45°
PACIFIC OCEAN
WASHINGTON
OREGON
IDAHO
MON
Principal Mer.
Willamette Mer.
Base Line
Boise Mer.
Base Line
Humboldt Mer.
BL
Mt Diablo Mer.
Base Line
CALI
NEVADA
UTAH
Salt Lake Mer.
Base
Base Line
Uintah Mer.
W

Animal Science

Structure of Unit:

Instruction in Animal Science is provided in two units.

Unit 1: Animal Reproduction

Lesson 1: Genetics
Lesson 2: Reproduction Systems
Lesson 3: Breeding Systems
Lesson 4: Methods of Breeding
Lesson 5: Breeding Livestock
Lesson 6: Care at Parturition
Lesson 7: Palpation
Lesson 8: Artificial Insemination

Unit 2: Livestock and Poultry Diseases

Lesson 1: Bacterial, Viral, Nutritional, Fungal, and Miscellaneous Diseases
Lesson 2: Importance of Parasites
Lesson 3: External Parasites of Livestock and Poultry
Lesson 4: Internal Parasites of Livestock and Poultry
Lesson 5: Prevention of Parasites

Objectives:

Upon completion of these units, the student will be able to:

Unit 1: Animal Reproduction

1. Understand how genetic characteristics are passed from one generation to the next.
2. Identify part and function of livestock reproductive systems.
3. Describe the process of fertilization of the egg.
4. Identify causes of reproductive failures.
5. Discuss major systems of breeding.
6. Select a method of breeding livestock which fits their ranch/farm best.
7. Know breeding ages of various species of livestock.

Unit 1: (continued)

8. Understand the reproductive cycle of livestock.
9. Care for various species of livestock during parturition.
10. Assist an animal during parturition.
11. Pregnancy test by palpation.
12. Artificially inseminate livestock.

Unit 2: Livestock and Poultry Diseases

1. Identify and describe symptoms of common livestock and poultry diseases.
2. Give oral report on a livestock or poultry disease important to them (Information on Informative Speeches available in Unit VI of this guide).
3. Describe prevention and control of common livestock and poultry diseases.
4. Note veterinarians discussion and main points about livestock and poultry diseases.
5. Understand the importance of good sanitary practices for livestock and poultry health.
6. Appreciate the importance of parasite control to economic livestock and poultry production.
7. Report on one internal and one external parasite important to their ranch/farm (Information on Informative Speeches available in Unit VI of this guide).
8. Understand host, life cycle, damage, symptoms, and control measures for major parasite problems.
9. Develop a plan for parasite prevention for their ranch/ farm.

References:

1. Vocational Instructional Services, Curriculum Materials, Texas A&M University.
2. The Stockman's Handbook, E.M. Ensminger, Interstate, 1978.

3. OSU Extension Publications, OSU Extension Service, Corvallis.
4. **Make wise use of a local Veterinarian for classroom presentations and field demonstrations.
5. **Make wise use of local ranchers/farmers with skills in veterinarian sciences for classroom presentation and field demonstration.
6. Unit IV - Informative Speeches - Oregon AgIII Curriculum Guide (This guide).
7. VEP Film Strips and Cassettes, Vocational Education Productions, California Polytechnic State University, San Luis Obispo, CA 93407.
8. 4-H Vet Science Program: OSU Extension Service.

Instructor Activities:

1. Prepare overheads and handouts.
2. Use "The Stockmans Handbook" as a reference for student research on individual diseases and parasites which students will present orally.
3. Tie career job information to instructional areas as they are presented.
4. Use veterinarians and local ranchers/farmers as a resource for yourself and the students.
5. Help students prepare Informative Speeches using Unit VI of this guide.

Student Activities:

1. Take notes on material presented.
2. Participate in discussion and lab activities for the topics presented.
3. Give oral presentations on one disease and two parasites. (Use Unit VI of this guide to help students prepare informative speeches).
4. Perform skills presented in unit (i.e., give shots, sanitize, drench, take rectal temperature, A.I., palpate, plan a disease control system).

ANIMAL SCIENCE
Glossary of Terms
(Animal Reproduction)

1. Abortion - The presentation of a dead, undeveloped fetus.
2. Alleles - One member of a pair (genes "P" and "p").
3. Grade animal - An animal with non-purebred ancestors.
4. Asexual - A method of reproduction performed by the division of a single cell.
5. Rotational Breeding - The using of one of three different breeds of cattle as a sire periodically. This maintains a high level of heterosis.
6. Egg Cell - A female germ cell.
7. Germ Cell - A cell from which new individuals are produced.
8. Sperm Cell - Male germ cell.
9. Lethal Characters - Genes that cause death in animals.
10. Chromosomes - Bodies found in the nucleus in pairs that contain genes which determine the hereditary characteristics of animals.
11. Conceive - A female animal that becomes pregnant.
12. Copulation - The physical union of the two sexes.
13. Criss Crossing - A method of breeding crossbred animals. Brahman bulls are usually bred to cows with British breeding and British bulls are usually bred to Brahman cows.
14. Estrus Cycle - The interval between heat periods.
15. Cytoplasm - The outside or covering over the nucleus.
16. Anatomic Defects - Defects in the anatomy of animals.
17. Veneral Disease - A contagious disease that is usually contacted by animals having sexual intercourse.
18. Incomplete Dominance - Neither character being dominant.
19. Egg - A reproductive cell.
20. Estrus - The period that an animal is in heat.

21. Fertility - Being fertile.

22. Fetus - Unborn animal.

23. Signoid Flexure - An "S" shape muscle that allows the penis to extend from the sheath.

24. Flushed - An animal that receives extra feed and care prior to breeding.

25. Gametes - A reproductive cell before fertilization (male or female).

26. Gene - Minute particles found in the chromosomes that determine the hereditary characteristics of animals.

27. F1 Generation - The first generation out of a cross of two animals of different breeds.

28. Marking Harness - A harness strapped to a ram that marks a ewe's rump with crayon when she is bred by a ram.

29. Standing Heat - A female that freely accepts the stallion.

30. Scrotal Hernia - A hernia in the scrotum of an animal.

31. Heterosis - Hybrid vigor.

32. Heterozygous - An animal that carries genes for two different characters (impure).

33. Homozygous - An animal that carries genes for the same character (pure).

34. Incross - The progeny from the cross of individuals of inbred lines of the same breed.

35. Sexual Infantilism - The failure to develop sexually.

36. Lameness - An animal that is limping or cripple. It is usually caused by an injury.

37. Sex-linked - Characters developed from genes located on sex chromosomes. The character may be used to determine the sex of an animal. Barring of Barred Plymouth Rock chickens is an example.

38. Maturation - The process of maturing.

39. Backcross Method of Mating - The breeding of F1 females to a bull of the same breed as the F1's parents.

40. Hand Mating - The turning of a cow with the bull.

41. Mitosis - The stages in cell division, or the division of cells.

42. Mutation - A genetic change in animals that is hereditary.

43. Nucleus - The vital part of the cell which digests food, grows, and divides.

44. Ova - A female egg or gamete.

45. Crossing Over - The interchange of the entire segment of chromosomes.

46. Ovulation - The discharge of eggs from the ovary.

47. Parturition - The giving birth to young.

48. Heat Period - The period in which an animal is in heat (estrus).

49. Potent - A male capable of producing pregnancy.

50. Presentation - An animal giving birth.

51. Protoplasm - The living materials within a cell.

52. Puberty - The age at which an animal reaches sexual maturity.

53. Conception Rate - The rate or percentage of animals becoming pregnant.

54. Concentrate Ratio - The amount of concentrates in comparison to the amount of other feeds fed.

55. Recessive - A gene that appears when a dominant character is not present.

56. Breeding Season - The season in which animals are bred.

57. Sexual - A method of reproduction which involves the union of sperm and an egg.

58. Spermatozoa - Male germ cell.

59. Sperms - Male germ cells.

60. Sterility - Not fertile. Animals that are incapable of reproducing are sterile.

61. Tagging - The removal of tags from sheep by shearing.

62. Tags - Large locks of britch wool clotted with dung and dirt.

63. Fertility Test - A test to determine if an animal is fertile.

64. Performance Test - A test to determine the performance of certain characteristics (usually growth factors) in animals.

65. Progeny Test - A test to determine the heritability traits of the offsprings of an animal.

66. Topcross - Breeding two different families of the same breed.

67. Topcrossbred - The progeny from the mating of inbred sires with noninbred dams of a different breed.

68. Topincross - The progeny from the mating of an inbred sire with a noninbred dam of the same breed.

69. Inherited Trait - A characteristic inherited by the offspring.

70. Twinning - Giving birth to twin lambs.

71. Identical Twins - Two animals of the same sex which developed from a single fertilized egg.

72. Twitch - A method of restraint used on horses to divert their attention from the area of pain. A twitch applies pressure to the sensory nerves of a horse's lips. It usually is a small loop made from rope with a wood handle to twist the loop.

73. Uterus - Female reproductive organ connected to the oviducts. Fetal development occurs here.

74. Aesthetic Value - The value or pleasure that wildlife gives to individuals by its presence.

75. Viable - A healthy, living cell or organism.

76. Virile - A male capable of functioning in copulation.

77. Cell Wall - The membrane around a cell.

ANIMAL SCIENCE

Glossary of Terms

78. American Standard of Perfection - A book published by the American Poultry Association, Inc. that gives a complete description of all recognized varieties of fowls.

79. Anus - The posterior opening of the digestive tract.

80. Femoral Artery - The main artery carrying blood to an animal's hind legs.

81. Aspirated - To draw by suction.

82. Holding Brand - A symbol or number burned into an animal's hide that is a requirement for registration with some cattle breed registry associations. The brand must be recorded in the association office.

83. Standard-Bred - Any breed or variety of poultry included in the American Standard of Perfection.

84. Breeder - The owner of the dam when she was bred. The definition holds true in registering all classes of livestock.

85. Centrosome - A minute protoplasmic body sometimes held to be the dynamic center of mitotic activity.

86. Cesarean Section - Technique used in some S. P. F. laboratories to remove unborn pigs from the sow. Pigs are removed through the wall of the uterus, leaving the sow capable of further reproduction.

87. Corpus Luteum - A hard teat-like projection on the surface of the ovary that forms in the cavity left by the released ovum.

88. Genitalia - The organs of the female reproductive tract including the external genital organs.

89. Germ Plasm - Term for the reproductive and hereditary substance of individuals which is passed on from the germ cell in which an individual originates in direct continuity to the germ cells of succeeding generations. By it, new individuals are produced and hereditary characteristics are transmitted.

90. Closed Herd - A herd that admits only S. P. F. stock for replacements or additions.

91. Hysterectomy - Technique used in some S. P. F. laboratories to remove unborn pigs from the sow. The entire uterus is removed with the pigs inside. This operation makes the sow useless, and she is slaughtered immediately after the operation.

92. Non-Specific Intestinal Infections - Diseases of the intestinal tract that are unclassified as to name and specific cause.

93. Artificial Insemination - The deposition of spermatozoa in the female genitalia by artificial rather than by natural means.

94. Morphology - The features comprised in the form and structure of an organism or any of its parts.

95. Motility - Active movement in artificial insemination of the sperm in a male's semen.

96. Private Herd Number - The number assigned to registered animals by their individual owners. It is required by some breed registry associations in the identification of registered animals.

97. Ovum - The female germ cell or egg.

98. First Owner - The owner of an animal at its birth.

99. Oxytocin - The hormone released from the posterior pituitary of the female which causes contractions of the uterus at the time of breeding. These contractions aid the movement of sperm through the cervix and into the uterine horns where fertilization of the egg normally occurs. Oxytocin also causes milk letdown at milking time.

100. Palpation - A method of pregnancy determination in cattle in which the arm is inserted into the cow's rectum and the reproductive tract is felt for pregnancy indications.

101. Specific-Pathogen Free - Swine that are obtained by laboratory methods designed to eliminate certain diseases of the respiratory and digestive tracts.

102. Primary S. P. F. Pig - Pig removed from its mother just before the normal birth date by a surgical process (Cesarean section or hysterectomy) and raised in laboratory isolation.

103. Secondary S. P. F. Pig - Pig that is farrowed and raised normally by a primary or secondary S. P. F. mother.

104. Preconditioning - Term refers to cattle that have been weaned, castrated, dehorned, vaccinated for several diseases, wormed, treated for grubs, and taught to eat from bunk-type feeders before being shipped to the feedlot.

105. Rectovaginal - Pertaining to the rectum and vagina.

106. Scrub - Usually an undersized, inferior animal of very mixed or unknown parentage, without definite breed type and completely unknown ability to transmit desirable dairy or beef characters to its offspring.

107. Speculum - A tubular instrument inserted into the vagina of the female for inspection and for insemination by use of the insemination tube.

108. Spermatozoa - The plural form of spermatozoon. The male sexual cell or sperm cell of an animal, the function of which is the fertilization of the egg.

109. Testis - A male reproductive gland commonly referred to as testicle.

110. Vasectomized - Surgical removal of the vas deferens or a portion of it to make the male sterile or incapable of producing live sperm.

111. Embryonic Vesicle - Sac containing the developing embryo.

112. Viability - Pertaining to sperm cells in the semen, alive with such form and development of organs as to be normally capable of living.

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 1: Genetics (2 hrs.)

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Genetics

Genetics has been defined as a study of why we are what we are. It has also been described as a study which deals with the differences and similarities among individuals related by descent.

George Mendel, a monk and an untrained scientist, discovered the process of inheritance while pursuing his hobby of breeding peas. However, Mendel's work was not recognized until after his death when his findings were duplicated by Corners, de Vries, and von Tschemak in 1900.

2. The Cell and Cell Division

An animal's body is made up of millions of tiny structural units called cells. Some cells are so small that if laid side by side, it would take 250,000 of them to measure an inch. Animal life starts from a single, fertilized cell.

Transparency No. 1

A cell is composed of a cell wall and protoplasm, and protoplasm consists of a nucleus and cytoplasm. The nucleus contains chromatin which forms bodies called chromosomes. The chromosomes carry minute cells called genes, which determine the hereditary characteristics of animals and are transmitted to the offspring from the parents. All animals of the same specie have the same number of chromosomes and all animals have millions of genes. It is because of these millions of genes and possible combination of these genes that no two animals are alike.

The number of chromosomes found in the cell of man and common animals are as follows.

Man	46	Horse	60
Swine	80	Goat	60
Cattle	60	Mouse	40
Sheep	54	Rat	42
Chicken	78		

Growth in animals is largely due to an increase in the number of cells rather than cell size. As cells divide, the animal increases in size (grows).

Transparency No. 2

The above transparency shows the steps in cell division. A cell divides into two cells, then these two cells divide into four cells, and so on until an animal becomes an adult. The division of cells is called mitosis.

3. Methods of Reproduction

The two general methods of reproduction are sexual and asexual. All domestic animals reproduce by the sexual method of reproduction, which involves the union of a sperm and an egg. Bacteria and some plants are reproduced by the asexual method, which is performed by a single division of a cell.

All animals that reproduce sexually start from a single, fertilized cell. New individuals are produced from productive cells, often called germ-cells or gametes. Male germ-cells are called sperms or spermatozoa, while female germ-cells are called eggs or ova.

Transparency No. 3

Before the male and female germ-cells unite, they go through a process called maturation, a process where the chromosomes in both the male and female germ-cells are reduced to one-half of the original number. The maturation process in the male and female germ-cell are different. Only one in four of the female germ-cells are productive, while the male germ-cells will reproduce after uniting with an egg.

4. The Sperm and the Egg

The volume of semen and the number of sperms are influenced by the sexual use, health of the male, season of the year, the age of the male, and the specie. By volume of semen per animal, the boar, stallion, bull, ram and rooster would be ranked in that order. Ranking them on the average sperm concentration per service, the above mentioned animals would be ranked as follows: rooster, bull, ram, boar, and stallion. The average number of sperm cells in a single service runs into the millions.

Transparency No. 4

The sperm is very small and must be magnified many times before it is visible. Because the egg contains the food material for the developing young, it is much larger than the sperm. Some eggs are 1/150 of an inch in diameter. The sperm and egg are the parent germ-cells and transmit all the characters that the offspring will inherit.

The number of offspring produced by the female will give an indication as to the number of eggs produced by a specie. A sow produces more eggs than a cow. All of the eggs produced by an animal are not fertilized. Sometimes a fertilized egg will separate into two parts, and each part will form an individual. These individuals are of the same sex, have similar features, and are called identical twins. Twins developed from separate fertilized eggs are referred to as fraternal twins and are not identical.

5. Dominant and Recessive Characteristics

A character is a trait or feature such as horns in cattle and the hair color in a certain breed of horses. The character itself is not present in the cell, but the cell has the ability (or that something) to produce the character. This something that produces character and affects its development is known as a factor or gene. All characters are not visible; and some are hidden by presence of others. An example is an animal that contains both polled and horned genes. The polled character is visible. The gene that hides another gene is said to be recessive. The dominant factor is designated by capitalizing the first letter of the factor, and the recessive factor is designated by using the lower case of the first letter of the dominant factor. For example, the dominant factor for polled would be designated by a P and the recessive factor, which is horned, would be designated with a p. A list of dominant and recessive factors is as follows:

Dominant	Recessive
Poultry	
Rose Comb	Single Comb
White Shanks and Skin	Yellow Shanks and Skin
Feathered Shanks	Clean legged
Black Plumage	White Plumage
Cattle	
Normal Size	Dwarf
Black Body	Red Body
White Face	Black Face
Polled	Horned
Dark Color	Light Color

Sheep

Polled	Horned
White Fleece	Black Fleece

Swine

Lopped Ears	Fox Ears
Mule Foot	Normal Foot
White Hair	Red and Black Hairs

Horses

Black Color	Chestnut
Gray Color	

6. Transmission of Characters

An individual that possesses both genes for a character is pure or homozygous for that character, while an individual that has genes which affect a character differently is impure or heterozygous for that character. Using the polled and horned characters as an example, the homozygous character for polled would be written PP and the heterozygous character is written as Pp. One should not confuse a purebred or an animal subject to registration with the word homozygous, which is used to indicate the genetic composition for any given character. Many registered animals are probably heterozygous for many genes.

As was mentioned in the discussion of the maturation process, the number of chromosomes in both the male and female germ-cells is reduced to one-half the original number. During this process, the gene pairs separate and go to different gametes. Therefore, after maturation only a single gene for a character is present in the reproductive cell, even though two genes for that character are always present in the fertilized egg or in the body cells of an individual (except for sex-linked characters which will be mentioned later).

Transparency No. 5

The above transparency shows two genes, representing the polled character in cattle, (PP or Pp) dividing during the maturation process. Genes P and p are known as alleles.

When recessive and dominant genes are united in the F1 generation, the dominant characters are carried by the progeny. Some of the animals in the F2 generation will shown dominant characters and others will show recessive characters.

Transparency No. 6

The "square" or "checkerboard" diagram (in the above transparency) is used to determine the probable results in breeding livestock. The male germ-cells are indicated in one margin (usually across the top) and the female germ-cells are indicated in the other margin. A cross between a bull homozygous for polled condition (PP) and cow homozygous for horned condition (pp) will produce only polled offsprings in the F1s (Fig. 1).

The offsprings from individuals heterozygous for the polled character (Pp) will be in the approximate ratio of three polled to one horned (Fig. 2). This is influenced by chance. The horned individuals produced from this cross (lower right-hand block, Fig. 2 in transparency) will not carry a gene for the polled character even though both parents were polled.

Using the information furnished above, one may wish to determine which animals in his herd are homozygous for the polled character. To determine if a polled bull is homozygous for the polled character, the bull should be bred to horned cows. If he is pure, his offsprings will be polled. From a bull with a heterozygous polled character, one-half of the calves will be horned and one-half will be polled. The above information may also be used to determine whether animals are homozygous or heterozygous for other characters.

A character can be the result of incomplete dominance. Roan color in Shorthorn cattle is the result of incomplete dominance of red and white. In this case, capital letters are used to designate each gene (R = red; W = white).

Transparency No. 7

Breeding Shorthorn animals as shown in Figure 1, would produce offsprings which would all be roan. The crossing of roan and white individuals, as shown in Figure 2, would produce offsprings in the approximate proportion of two roan to two white.

Up until now, single characters are all that have been considered. There are a number of characters in any cross. One could expect a ratio of 3:1 based on appearance in the offsprings of a cross between individuals heterozygous for a dominant character. The expected ratio with two pairs of heterozygous characters would be 9:3:3:1. With each additional character the ratio is changed to the extent of multiplying the preceding ratio by 3:1.

Transparency No. 8

Crosses between individuals impure for both horned and white-faced conditions (Pp Ww) should give a ratio of nine polled, whitefaced; three polled, colored faced, three horned, white faced; and one horned, colored faced. One can see that breeding animals to improve a particular character is complicated.

7. Determination of Sex

Sex of an animal is determined at the time of fertilization. The female has, in addition to the regular chromosomes, two sex chromosomes, designated by the letters XX. In the male only one sex chromosome (X) is present, and the other is designated as Y.

Transparency No. 9

After maturation one-half of the sperms and all of the eggs carry an X chromosome. The other one-half of the sperms carry a Y chromosome.

If in fertilization, a sperm carrying an X chromosome unites with an egg the offspring will be a female (XX). If a sperm carrying a Y chromosome unites with an egg, the offspring will be a male (XY).

In poultry the male carries two sex chromosomes, while the female carries only one. These are usually referred to by the letters Z and W. The letter W is used to indicate the sex chromosome in the female. Thus, the male would be designated a ZZ and the female as ZW. After maturation all of the sperms carry a Z chromosome, but only one-half of the eggs would carry Z. The square, as explained under Transparency No. 6, may be used to determine the sex.

8. Sex-Linked Characters, Crossing-Over, and Mutation

Certain genes located on the X or Z chromosomes are referred to as sex-linked. These characters may be used to determine the sex of an animal. For example, the barring of Barred Plymouth Rock chickens is a sex-linked character. If barred hens are mated with nonbarred males, all the barred chicks from this cross are males (ZBZb) and the nonbarred chicks are females (ZbW). There are other sex-linked characters.

In some cases there is an interchange of the entire segment of certain chromosomes as a result of crossing-over.

Occasionally, something will change a gene, and an individual is produced with a new character, a mutation.

9. Improving by Selection

Regardless of the breeding system followed, permanent improvements in livestock are usually the result of selection. The two kinds of selection are natural and artificial. Natural selection is the selection made of wild animals, while artificial selection is the selection made by rancher.

Since selection is the principal means of improving animals, one must be aware of the factors that cause variations which are environment, recombination of characters, and mutation.

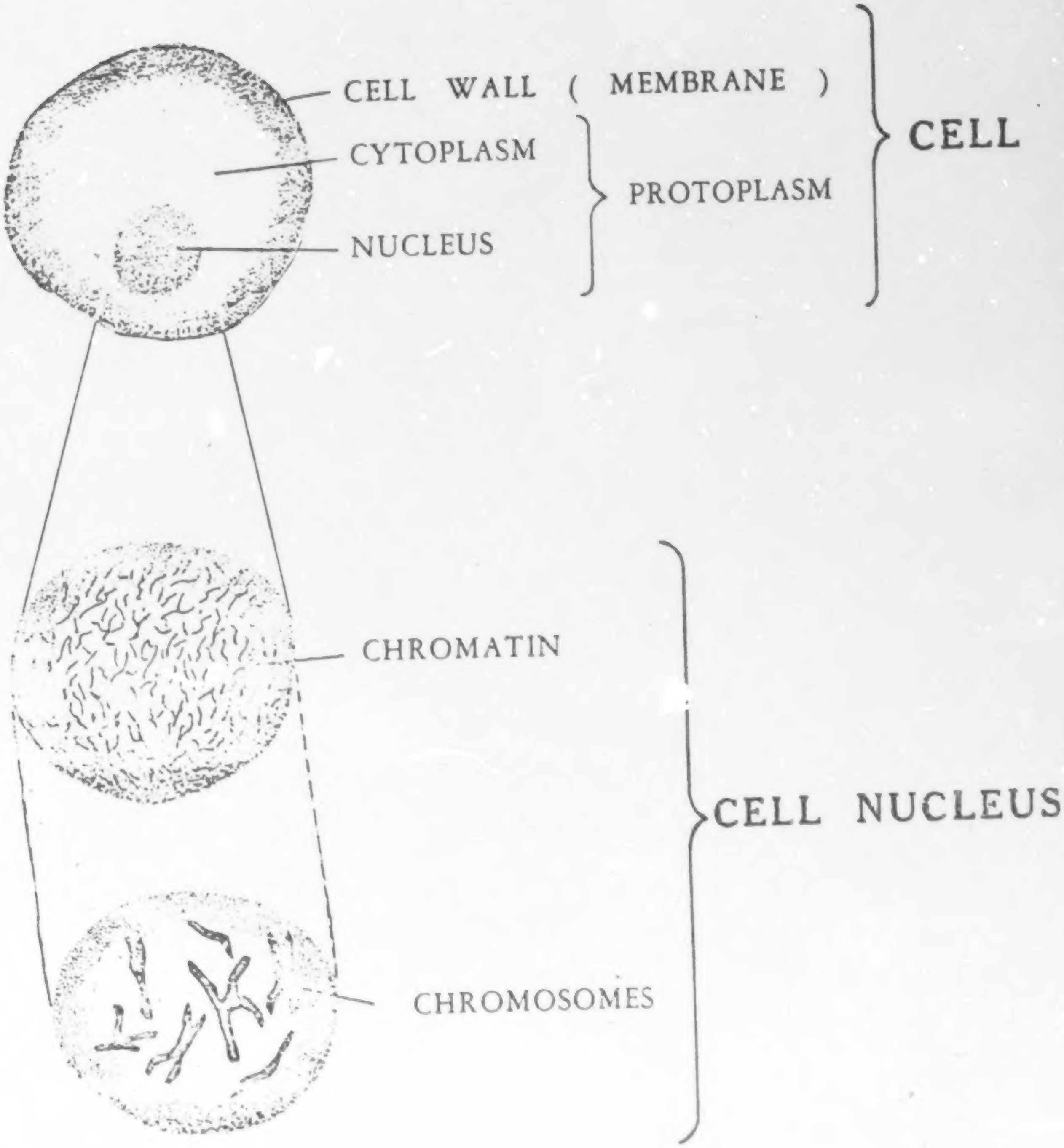
Environmental factors that cause variations in animals may be climate, amount and kinds of feed available, and methods of feeding. Animal selection certainly should not be based on factors that are influenced by environment.

Recombination of characters is one of the major causes of differences between animals. These differences are caused by the production of germ-cells with different characters. Selection based on these differences is permanent and is the best means of improving animals.

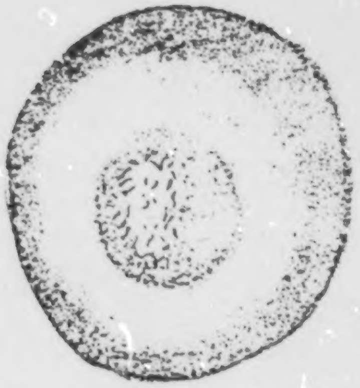
The third cause of variation is mutation. Selection based on a mutation is permanent. However, most mutations are not beneficial and progress is slow.

There are several methods of selecting animals which have been discussed in detail in other materials.

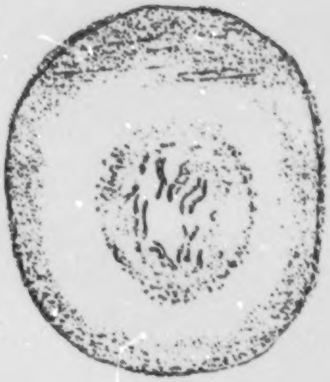
PARTS OF AN ANIMAL CELL


CELL WALL (MEMBRANE)
CYTOPLASM
NUCLEUS
PROTOPLASM
CELL
CHROMATIN
CHROMOSOMES
CELL NUCLEUS

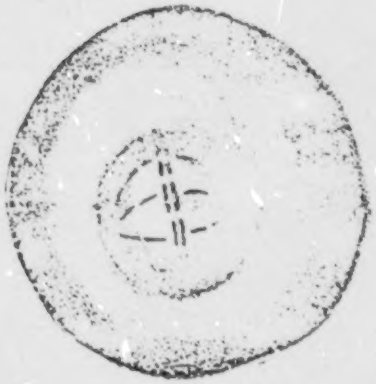
STEPS IN CELL DIVISION IN GROWTH (MITOSIS)



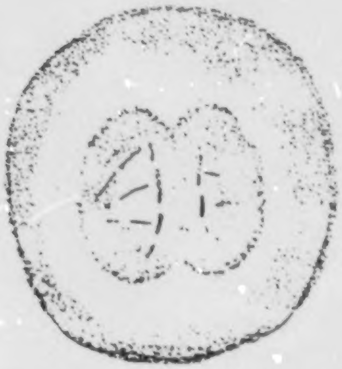
RESTING CELL



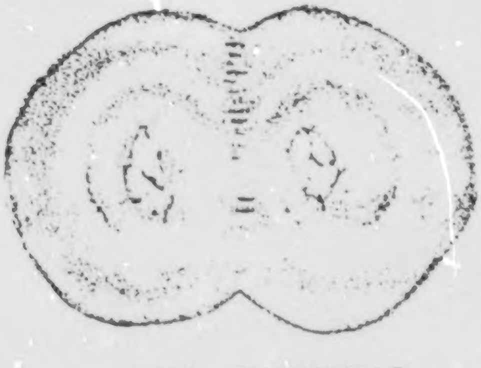
CHROMOSOMES FORMING



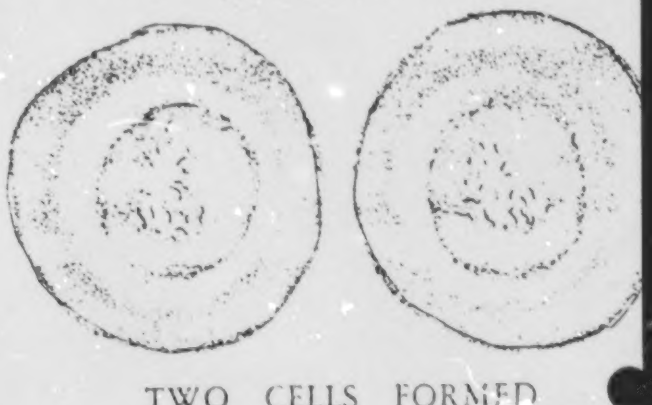
CHROMOSOMES DIVIDING



CHROMOSOMES AND NUCLEUS SEPARATING

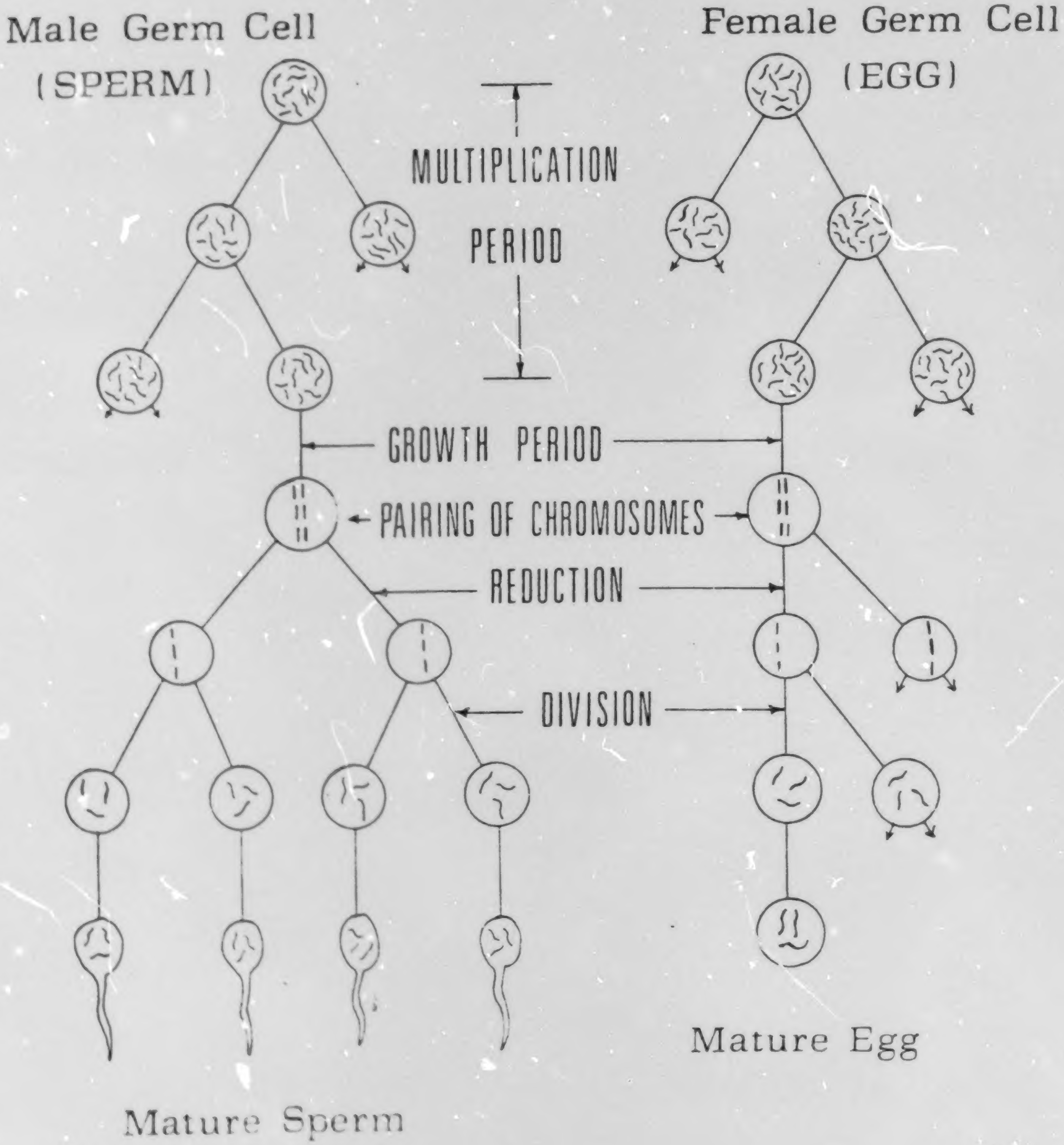


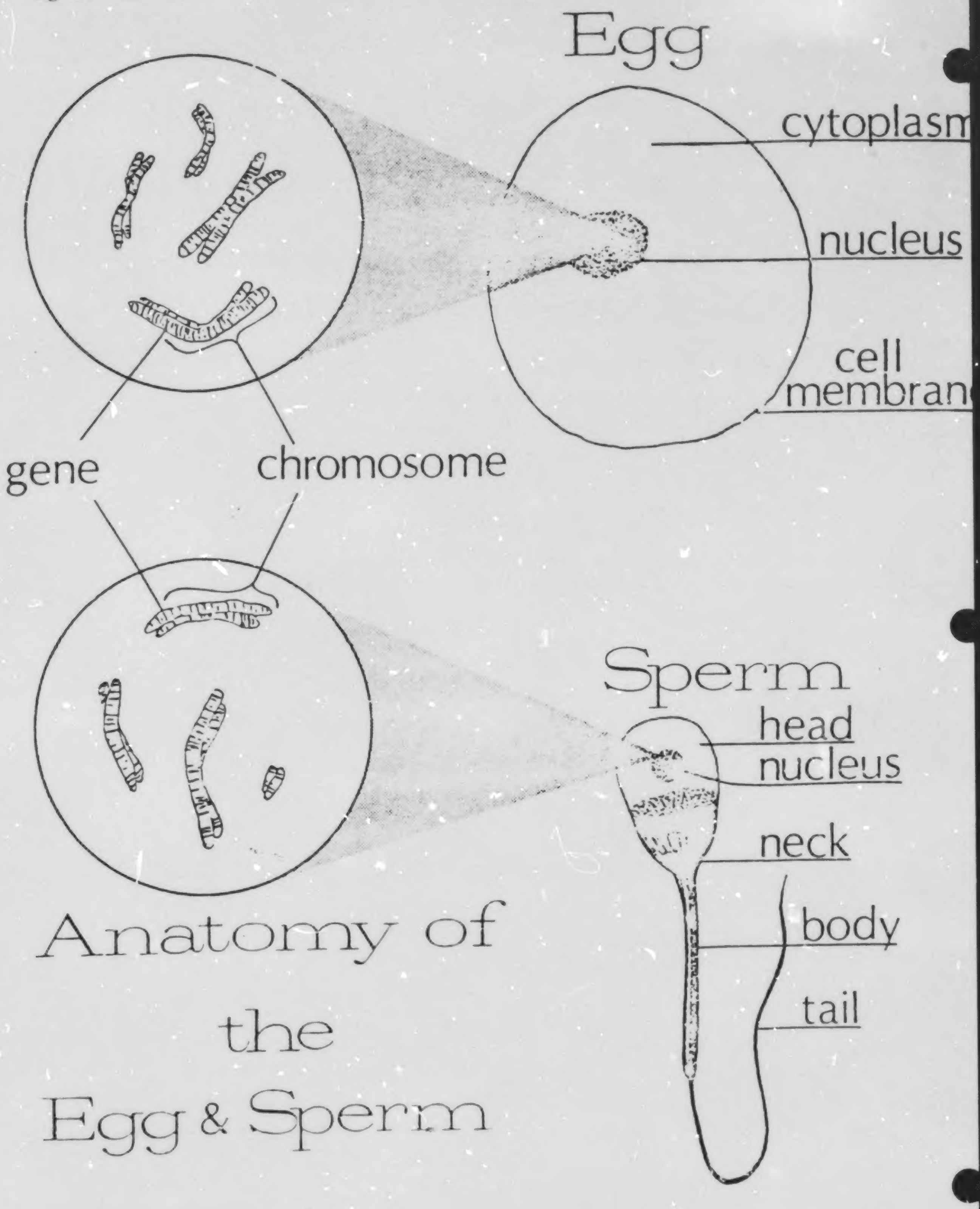
CELL DIVIDING



TWO CELLS FORMED

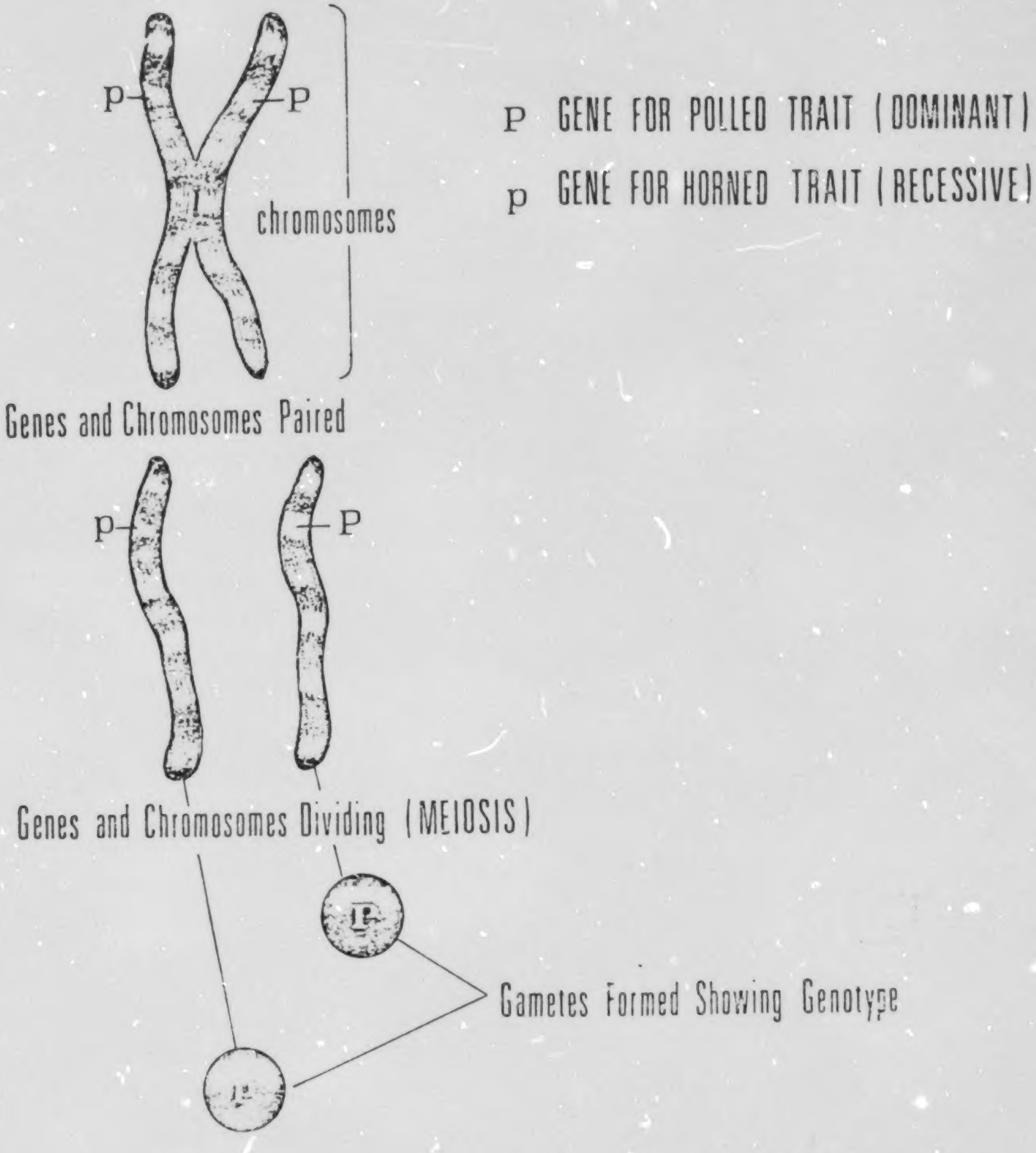
MATURATION PROCESS (MEIOSIS)


Male Germ Cell
(SPERM)
Female Germ Cell
(EGG)
MULTIPLICATION
PERIOD
GROWTH PERIOD
PAIRING OF CHROMOSOMES
REDUCTION
DIVISION
Mature Sperm
Mature Egg


Egg
cytoplasm
nucleus
cell
membran
gene
chromosome
Sperm
head
nucleus
neck
body
tail

Anatomy of the Egg & Sperm

AN EXAMPLE OF GENE PAIRS DIVIDING


p
P
chromosomes
P GENE FOR POLLED TRAIT (DOMINANT)
p GENE FOR HORNED TRAIT (RECESSIVE)
Genes and Chromosomes Paired
p
P
Genes and Chromosomes Dividing (MEIOSIS)
P
Gametes Formed Showing Genotype
p

A DIAGRAM FOR DETERMINING THE PROBABLE RESULTS FROM A DOMINANT AND RECESSIVE CHARACTER

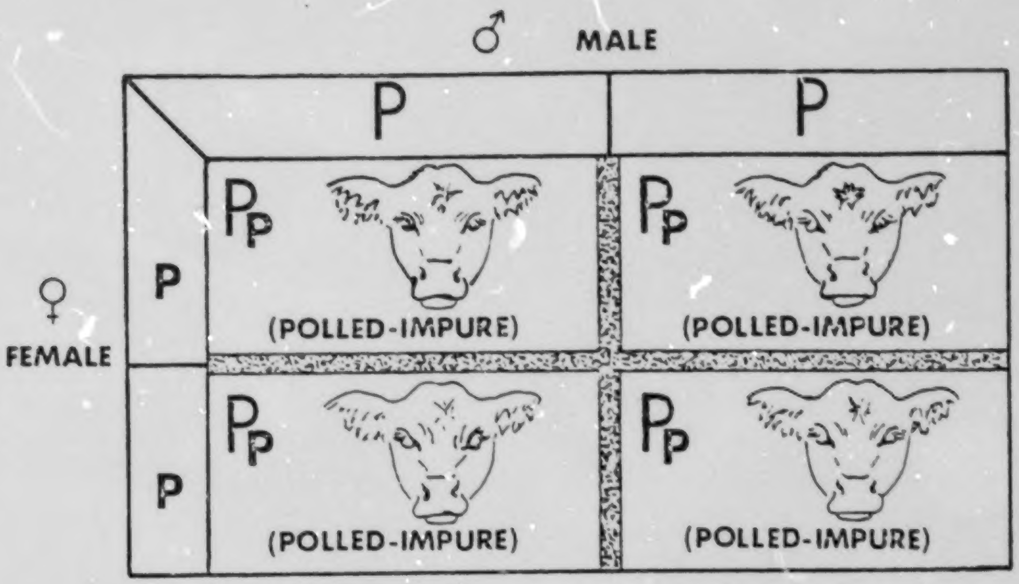

♂ MALE
P
P
♀ FEMALE
p
p
Pp
(POLLED-IMPURE)
Pp
(POLLED-IMPURE)
Pp
(POLLED-IMPURE)
Pp
(POLLED-IMPURE)

FIGURE 1.

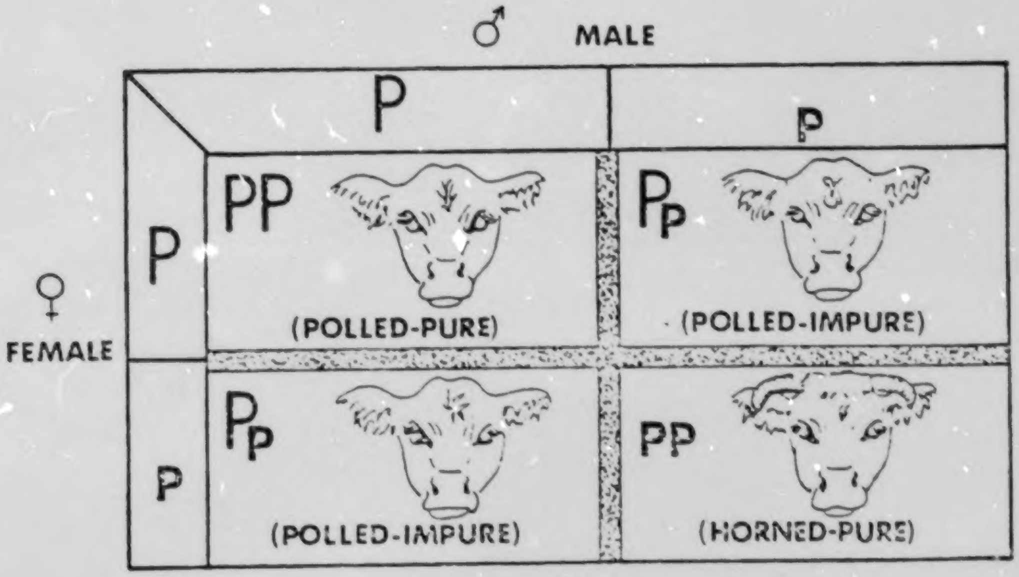

♂ MALE
P
p
♀ FEMALE
P
p
PP
(POLLED-PURE)
Pp
(POLLED-IMPURE)
Pp
(POLLED-IMPURE)
pp
(HORNED-PURE)

FIGURE 2.

COLOR DETERMINATION IN SHORTHORNS

♂ MALE

♀ FEMALE	R	R
W	RW (ROAN)	RW (ROAN)
W	RW (ROAN)	RW (ROAN)

FIGURE 1.

♂ MALE

♀ FEMALE	W	W
R	RW (ROAN)	RW (ROAN)
W	WW (WHITE)	WW (WHITE)

FIGURE 2.

A CROSS WITH TWO CHARACTERS

♂ MALE

♀ FEMALE

	PW	Pw	pW	pw
PW	☆ PPWW (POLLED, WHITEFACED)	☆ PPWw (POLLED, WHITEFACED)	☆ PpWW (POLLED, WHITEFACED)	☆ PpWw (POLLED, WHITEFACED)
Pw	☆ PPWw (POLLED, WHITEFACED)	★ PPww (POLLED, COLOREDFACED)	☆ PpWw (POLLED, WHITEFACED)	★ Ppww (POLLED, COLOREDFACED)
pW	☆ PpWW (POLLED, WHITEFACED)	☆ PpWw (POLLED, WHITEFACED)	✪ ppWW (HORNED, WHITEFACED)	✪ ppWw (HORNED, WHITEFACED)
pw	☆ PpWw (POLLED, WHITEFACED)	★ Ppww (POLLED, COLOREDFACED)	✪ ppWw (HORNED, WHITEFACED)	○ ppww (HORNED, COLOREDFACED)

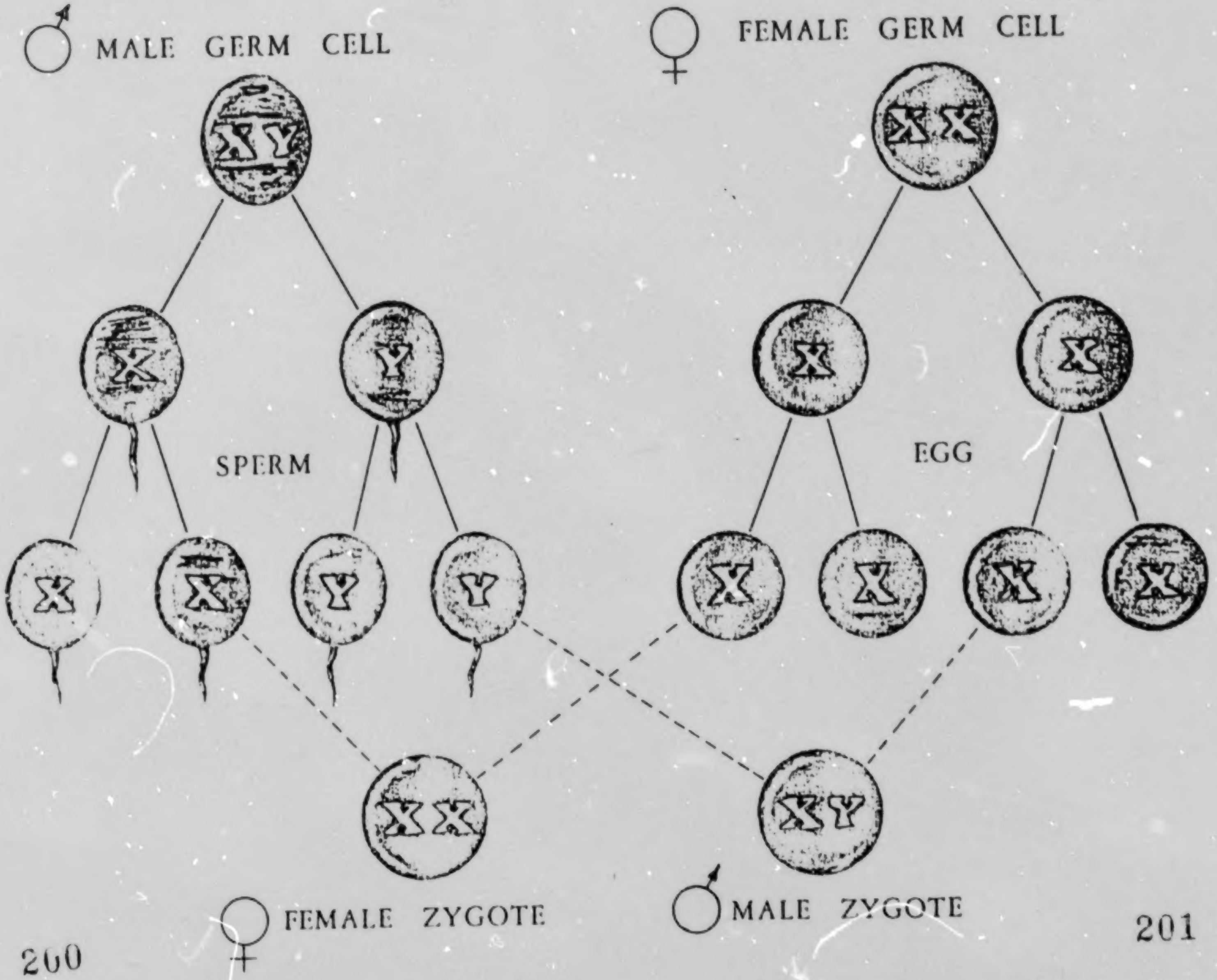
☆ – 9 POLLED, WHITEFACED

★ – 3 POLLED, COLOREDFACED

✪ – 3 HORNED, WHITEFACED

○ – 1 HORNED, COLOREDFACED

SEX DETERMINATION IN ANIMALS


♂ MALE GERM CELL
♀ FEMALE GERM CELL
XY
XX
X
Y
X
X
SPERM
EGG
X
X
Y
Y
X
X
X
X
XX
XY
♀ FEMALE ZYGOTE
♂ MALE ZYGOTE

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 2: Reproduction System (1 hr.)

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Animal Science

The term "reproduction" means the production of young animals to continue the species. Reproduction takes place after mating between the male and the female. During copulation, the male sperm cell is introduced into the female reproductive tract. The sperm then unites with the female egg cell. The union of the sperm and egg takes place in the female uterus where the new offspring (embryo, the fetus) is protected and nourished until parturition.

Transparency No. 1

2. Anatomy and Functions of Male Reproductive System

Scrotum - Contains the testes. Helps maintain the temperature of the testes at about 5° below body heat in order to prevent sterility.

Testes - produces the male sperm cells and testosterone, the male sex hormone.

Epididymis - long, greatly coiled tube which connects to each testis. It functions in storage, maturation, and transportation of sperm cells.

Vas Deferens - (sperm duct) - elongated tube which connects the epididymis with the urethra. Its function is transportation of sperm cells to the urethra.

Spermatic Cord - consists of vas deferens, smooth muscle, blood vessels and nerves. It is enclosed in a protective, fibrous sheath.

Seminal Vesicles - paired accessory glands which secrete seminal fluid into the urethra at the colliculus seminalis. The fluid functions in protection and as a transportation medium for the sperm.

Prostate Gland - found near the urethra and the bladder. It produces a fluid which is mixed with the seminal fluid.

Cowper's Gland - secretes a fluid similar to seminal fluid. It is secreted before ejaculation, and its purpose is to neutralize and cleanse the urethra.

Urethra - a tube extending from the bladder to the end of the penis. It functions as the transportation route for all the semen and urine.
Semen - term given to the sperm plus the added accessory fluids (seminal and prostate fluids).
Penis - external organ which deposits sperm cells within the female reproductive tract. In animals with a fibro-elastic penis, a signoid flexure allows the penis to be extended for copulation. Animals with a vascular penis have no such structure. The retractor penis muscle returns the penis into the sheath after mating.

Transparency No. 2

3. Anatomy and Function of the Female Reproductive System

Ovaries - two organs near the posterior end of the reproductive tract. They secrete the female sex hormones, estrogen and progesterone, and form the corpara lutea (plural of corpus luteum).
Oviducts - (Fallopian Tubes) - two tubes that carry eggs from the ovaries to the horns of the uterus. They lie close, but are not attached to the ovaries. The funnel shaped end of each oviduct near the ovary is called infundibulum.
Uterus (Womb) - an organ with two horns (branches) that are connected to the oviducts. Fetal development occurs here. The male semen is deposited either in the posterior uterus or mid-cervix regions.
Cervix - neck of the uterus. Separates the uterus from the vagina, acting as a valve.
Vagina - a passage way between the cervix and the vulva. The vagina expands to pass the fetus at birth.
Urethra - carries urine from bladder to vagina.
Clitoris - sensory and erectile organ of the female located just inside the vulva.
Vulva - the external opening of the reproductive and urinary tracts.

Transparency No. 3

4. Anatomy and Function of Male Reproductive System (Poultry)

Testes - produce sperm cells and seminal fluid.
Vas Deferens - connects testes with cloaca to carry seminal fluid and sperm cells.
Cloaca - connects the large intestine with the external opening (vent) of the alimentary canal. The vas deferens lead into the cloaca.
Papillae - organ located in the cloaca wall that introduces sperm cells into the oviduct.

5. Anatomy and Function of Female Reproductive System (Poultry)

Ovary - a chick has two ovaries and two oviducts but the right ovary and oviduct degenerate. Only the left ovary and oviduct develop and function. The ovary contains a large number of ova which develop into egg yokes.
Oviducts - carries the eggs through the reproduction tract. The ovary has five distinct parts:

1. The funnel of the oviduct receives the yoke from the ovary and stores the sperm cells.
2. The magnum secretes the thick white of the egg. The yoke remains here about three hours.
3. The isthmus receives the yoke and thick white and houses the egg about 1¼ hours while two shell membranes are added.
4. In the uterus, the thin white and the shell are added. The egg usually remains here approximately twenty hours.
5. The vagina receives the completed egg for a short time before it is laid, large end first.

Transparency No. 4

6. First Step In the Reproductive Process

The reproductive process begins with the heat period or estrus (time when the female will accept the male). The estrus cycle includes all of the events related to heat period in the non-pregnant female. The heat period is started by a ripe follicle, containing an egg, secreting the estrogenic hormone responsible for symptoms of heat.

In contrast, the ovary of a cow not in heat will have a corpus luteum (glandular structure) formed as soon as a ripened follicle ruptures and releases the egg. The corpus luteum secretes the hormone, progesterone, which maintains pregnancy.

7. The Process of Ovulation and When It Occurs

A ripened follicle ruptures, discharging an egg, near the end of heat or after the heat period. The egg drops into one of the oviducts where it may be fertilized if a viable sperm is present.

The corpus luteum appears soon after ovulation and secretes the hormone progesterone. This (1) causes the uterus to implant and nourish the embryo, (2) prevents other eggs from maturing, (3) maintains pregnant condition, and (4) assists in the development of the mammary glands.

If the egg is not united with a sperm, the corpus luteum atrophies, allowing another follicle to ripen and another heat period to occur.

If more than one egg is released and fertilized, multiple births occur. Animals originating in this manner are fraternally related (fraternal twins, etc.) and are no more alike than brothers and sisters from separate births. The occasional division of a single egg fertilized by a single sperm results in identical animals (identical twins).

Ovulation occurs at different times during and even after the heat period for different classes of livestock. This becomes especially important if the animal is bred by artificial insemination, and in determining breeding times for the hand mating breeding system. For example, cows should be bred toward the end of heat, or shortly after. Ewes and goats are to be bred near the middle of the heat period, and sows should be bred on the second day of heat. Mares are normally bred on the second day of heat, and every other day thereafter throughout the heat period, because ovulation may occur at any time. The sperm will remain alive and viable for at least 24 hours within the female's reproductive tract.

Transparency No. 5

8. The Process of Fertilization; How and Where It Is Accomplished

Fertilization is the union of the sperm and the egg. In the process of natural mating or artificial insemination, the semen containing the sperm is deposited within the vagina of the female. The sperm cells ascend the reproductive tract through the cervix, uterus and into the oviducts. If the sperm cells are deposited at the proper time in relation to ovulation, a sperm will unite with an egg in the upper part of the oviduct. (In cattle, sperm live only 24 to 30 hours in the female reproductive tract and the unfertilized egg will live approximately 12 hours.)

The fertilized egg passes down the oviduct into the uterus. The embryo becomes attached to the mucous membrane of the uterus when it receives nourishment and is protected until fully developed. If no sperm unites with the egg, the female does not conceive, the egg cells are absorbed by the body, and the period recurs.

Transparency No. 6

9. Fetus Position During Gestation

The illustration at the top of the transparency indicates the normal position of fetus during gestation. The rear of the fetus is toward the rear of the cow and the legs of the fetus are folded underneath its body. The back of the fetus is toward the back of the mother. The position of the fetus will shift and change throughout pregnancy.

The lower illustration shows the beginning stage of parturition. Following the first labor pains, the first water bag appears, increases in size, and ruptures from the weight of the contents. The second water bag (amniotic bladder) soon follows with the fetus. As the second water bag ruptures, the labor pains become more intense and presentation soon follows. Normally, the front feet will appear first, followed by the nose which is resting on the front legs. After the head, the shoulders, middle, hips, rear legs and feet appear.

10. Reproduction In Poultry; How Poultry Differs from Livestock

Sperm are introduced into the oviduct in the cloacal wall of the female by the papillae in the wall of the male. The sperm move up the oviduct to the funnel of the oviduct where fertilization takes place. It is possible for fertile eggs to be produced within 24 hours after mating. Sperm cells will remain in the oviduct for 2 to 3 weeks, retaining their full viability for about 6 days. The fertilizing ability of sperm cells decreases to approximately 50% on the 10th day, and to approximately 15% on the 19th day. Occasionally, eggs may be fertilized up to 26 days after a single insemination.

As an egg yoke is released from the ovary of the hen, it falls into the funnel of the oviduct where the female germ cell on the outer edge of the yoke is fertilized. The fertilized yolk then moves through the reproductive tract, acquiring the thick white, the shell membranes, the thin white, and the shell.

With the proper temperature and humidity after the egg is laid, the embryo continues to develop. The embryo is nourished by the egg contents which are completely consumed at the end of the 21 day incubation period.

11. Reproductive Failures in Livestock

Sterility, either permanent or temporary, may be caused by a number of reasons. Livestock reproduction failures may be due to a particular disease or a specific defect. Occasionally, a series of minor disturbances may halt reproduction.

Some of the more common reasons for reproductive failure are:

Anatomic Defects - the most common male defect is the retention of the testes in the abdominal cavity, rather than having them descend into the scrotum prior to birth, as is normally done. This condition is known as cryptorchid, and results in a sterile male. If only one testis is retained, the animal is said to be monorchid, but is not sterile. However, his sperm production is reduced. These are inherited traits, and animals showing this tendency should be avoided in the breeding program. Another common male defect is the scrotal hernia, also lack of exercise, malformed penis and periods of high temperature may cause sterility.

The best known female abnormality is that of the freemartin, the sterile female born with a twin brother. Only about 10% of these freemartins are normal animals Some other defects are: absence of ovaries or uterine horns, closure of cervix or other tubes.

12. Mechanical Injury of Male or Female Genital Organs

Injury to genital organs may be cuased by any number of means, principally by improper handling and fighting among animals. Diseases of reproduction tracts also are the causes of numerous calf losses, primarily through abortion at various stages of pregnancy. Four of the more common diseases are:

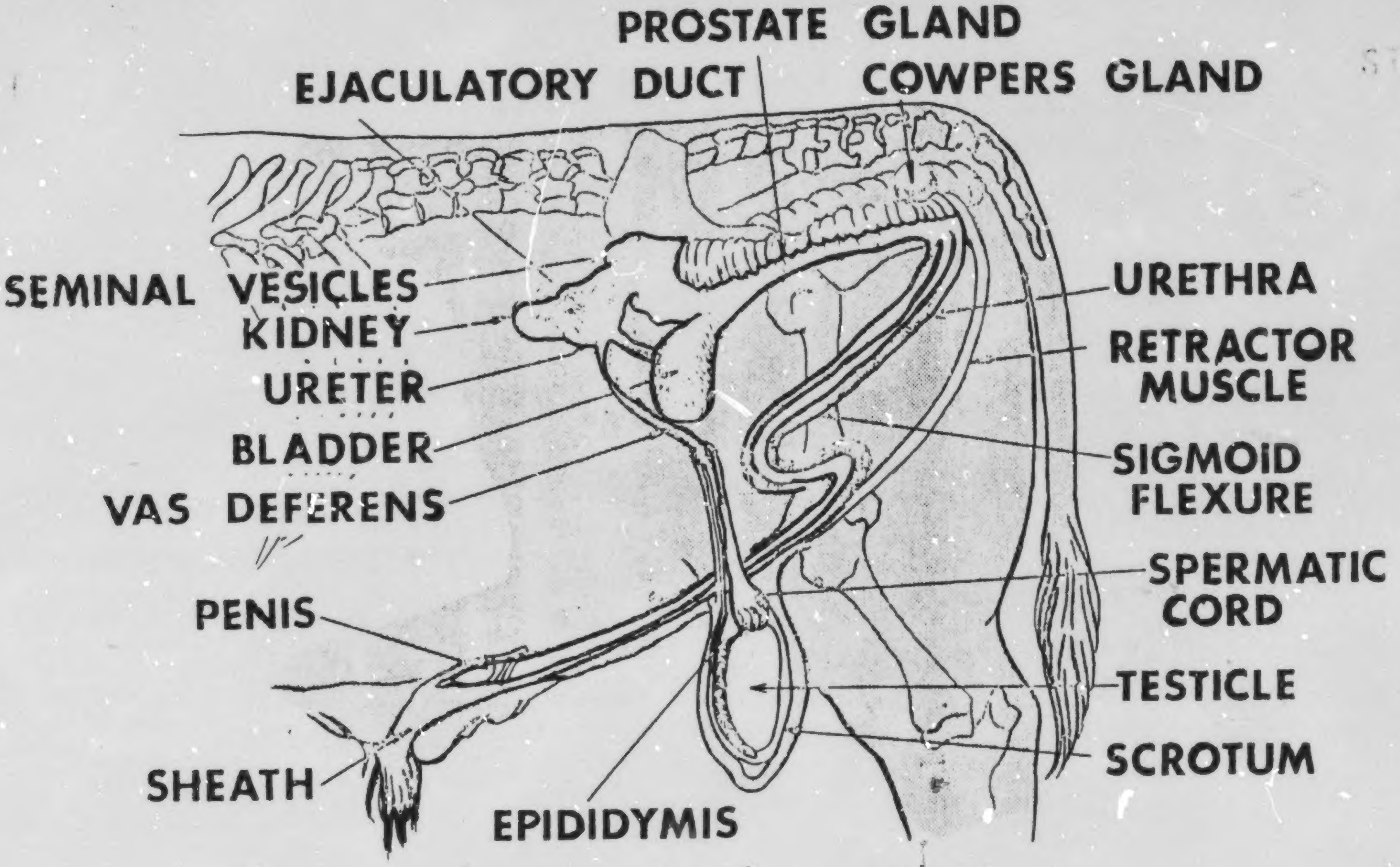
(1) Brucellosis
(2) Vibriosis
(3) Trichomoniosis
(4) Leptospirosis

Nutritional deficiencies - proper amounts of vitamins and minerals are essential to efficient reproduction, as well as to good general health and optimum daily gain. The following vitamins and minerals are known to affect reproduction:

(1) Vitamin A
(2) Vitamin E
(3) Phosphorous
(4) Calcium
(5) Cobalt
(6) Iodine
(7) Copper
(8) Iron

Endocrine Disturbances - some of the female reproductive disturbances are glandular in nature. The more common ones are: undeveloped reproductive tracts, irregular heat periods, sexual infantilism, abnormal function of corpus luteum and cystic follicle. Males may also suffer from glandular disturbances. Some of these are: sexual infantilism, lack of sex drive (libido) caused by lack of testosterone production, excessive fat as well as lack of finish and malformed or small testes.

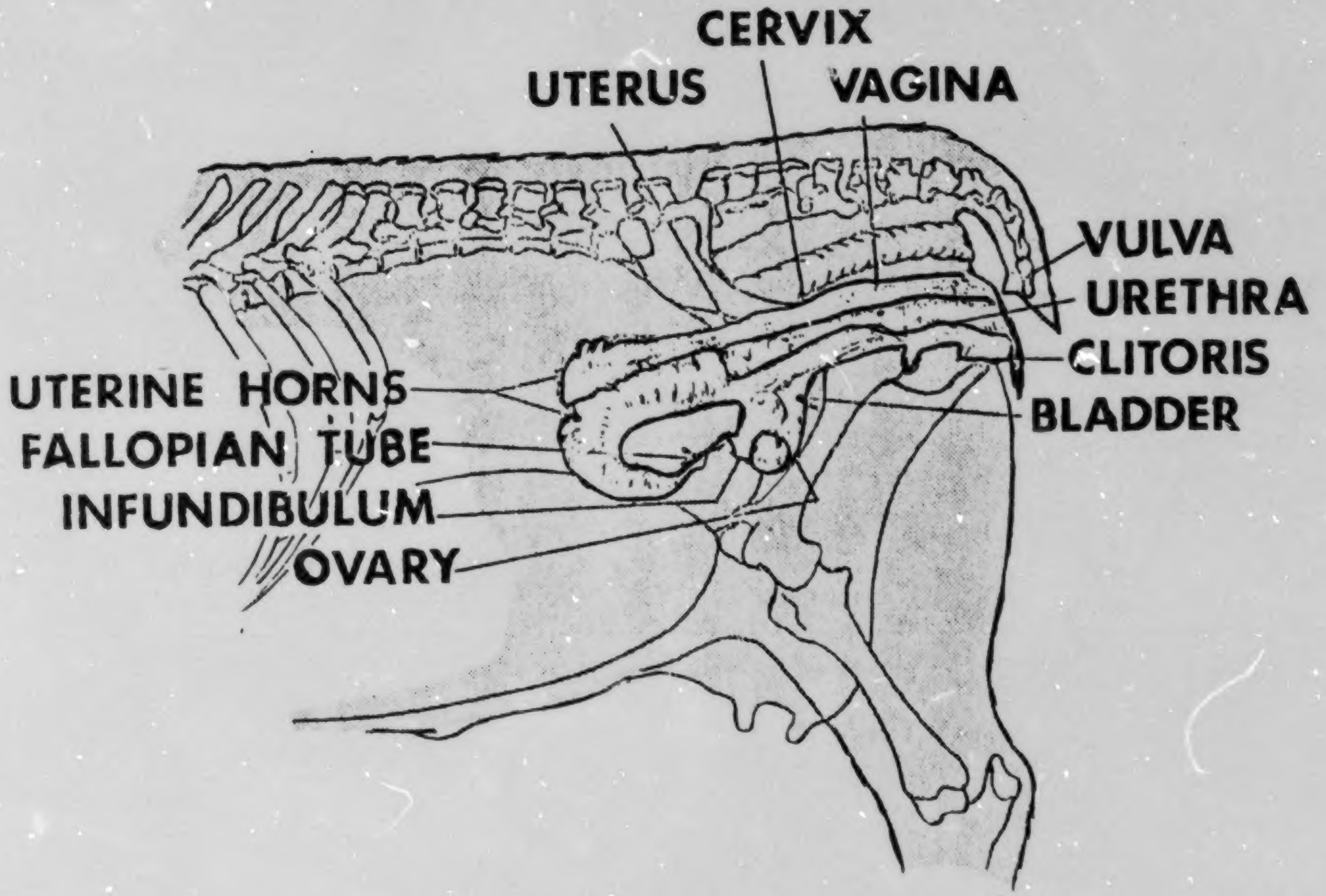
Genetic factors - some blood lines are recognized as having a high genetic factor for sterility, and should be avoided if possible also; inbreeding may cause decreased litter size and decreased fertility.


PROSTATE GLAND
EJACULATORY DUCT
COWPERS GLAND
SEMINAL VESICLES
KIDNEY
URETER
BLADDER
VAS DEFERENS
PENIS
SHEATH
EPIDIDYMIS
URETHRA
RETRACTOR MUSCLE
SIGMOID FLEXURE
SPERMATIC CORD
TESTICLE
SCROTUM

MALE REPRODUCTIVE SYSTEM

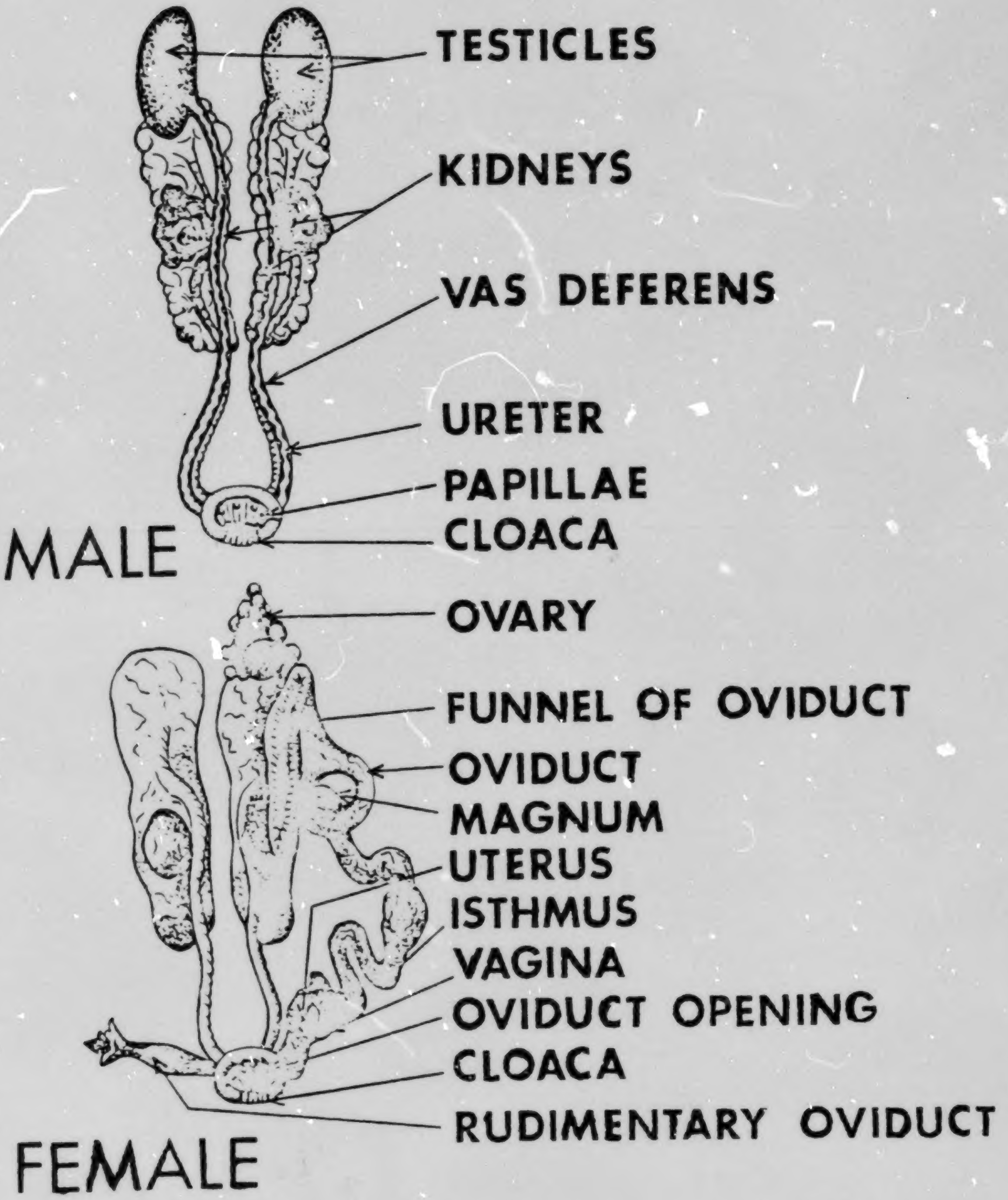
AgIII-III-39

TM-1

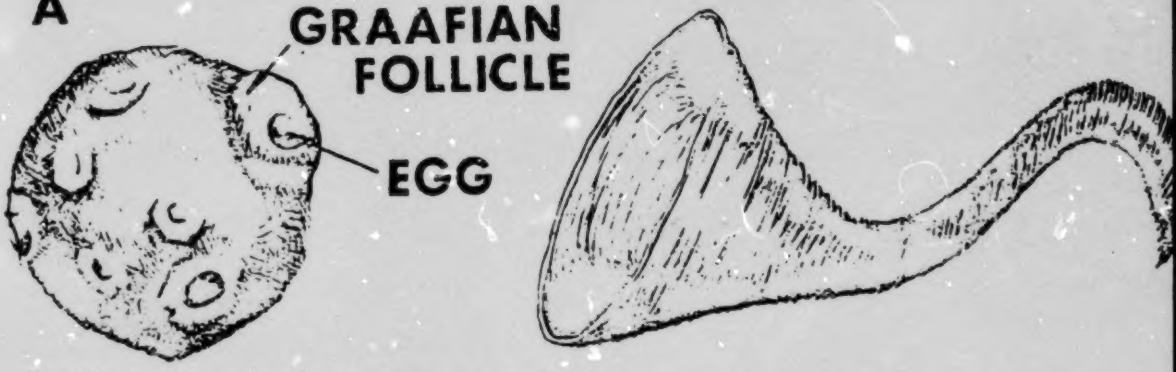

CERVIX
UTERUS
VAGINA
VULVA
URETHRA
CLITORIS
BLADDER
UTERINE HORNS
FALLOPIAN TUBE
INFUNDIBULUM
OVARY

FEMALE REPRODUCTIVE SYSTEM

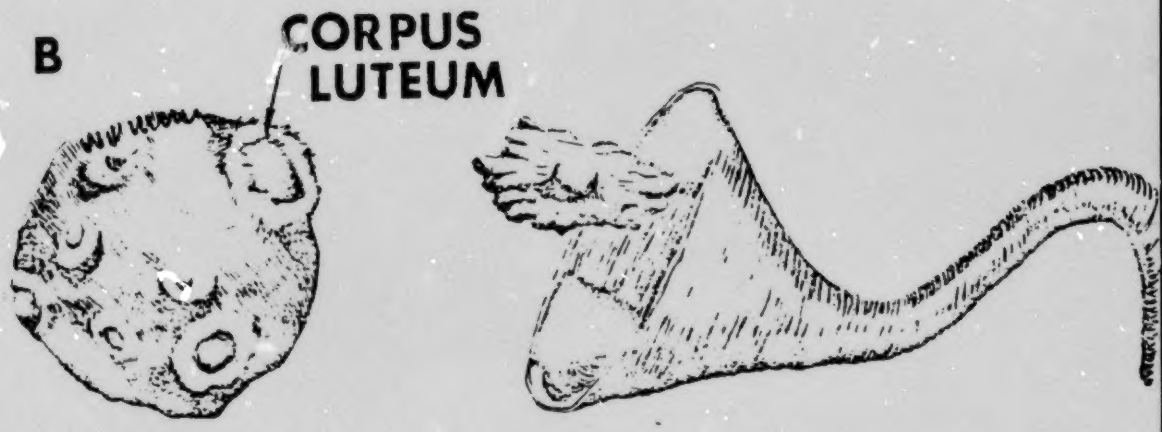
POULTRY REPRODUCTIVE TRACTS


TESTICLES
KIDNEYS
VAS DEFERENS
URETER
PAPILLAE
CLOACA
MALE
OVARY
FUNNEL OF OVIDUCT
OVIDUCT
MAGNUM
UTERUS
ISTHMUS
VAGINA
OVIDUCT OPENING
CLOACA
RUDIMENTARY OVIDUCT
FEMALE

OVULATION


A
GRAAFIAN FOLLICLE
EGG

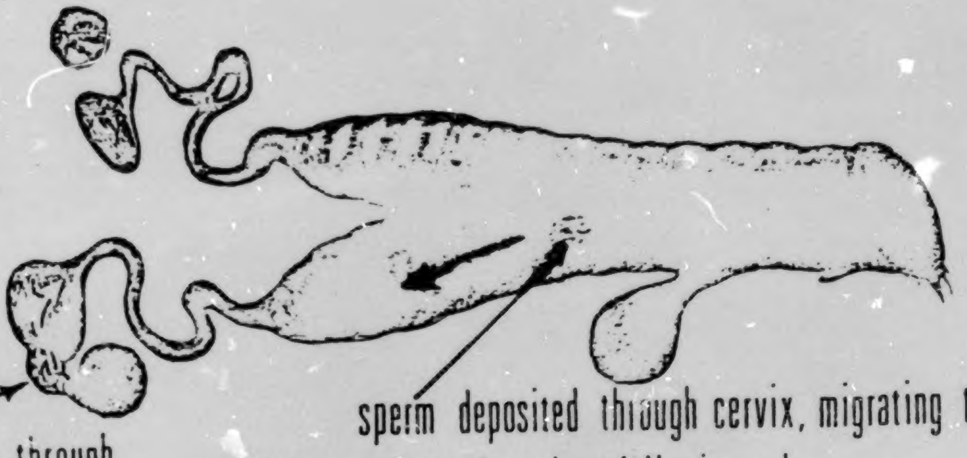
OVARY (DURING HEAT)


B
CORPUS LUTEUM

OVARY (NOT IN HEAT)

FERTILIZATION IN CATTLE

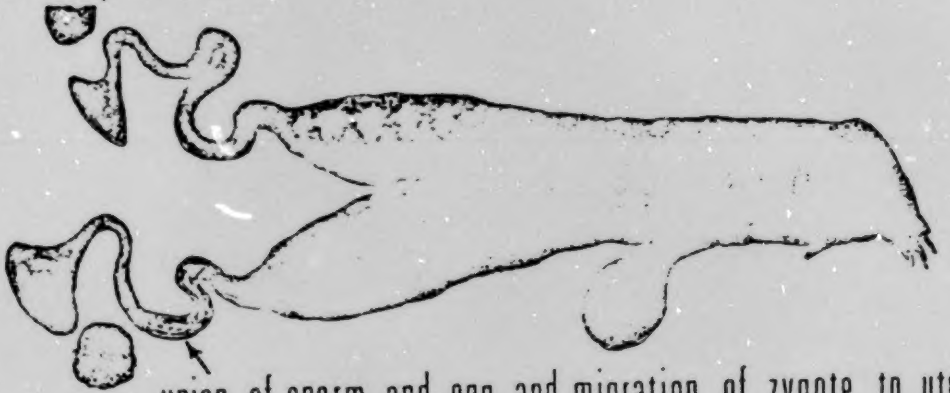
1.



egg passing through infundibulum into fallopian tube

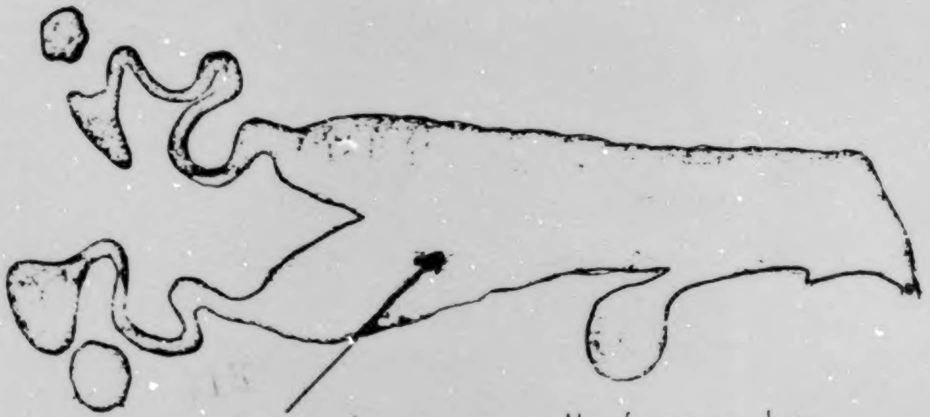
sperm deposited through cervix, migrating through uteran horn into fallopian tube

2.



union of sperm and egg and migration of zygote to uterus

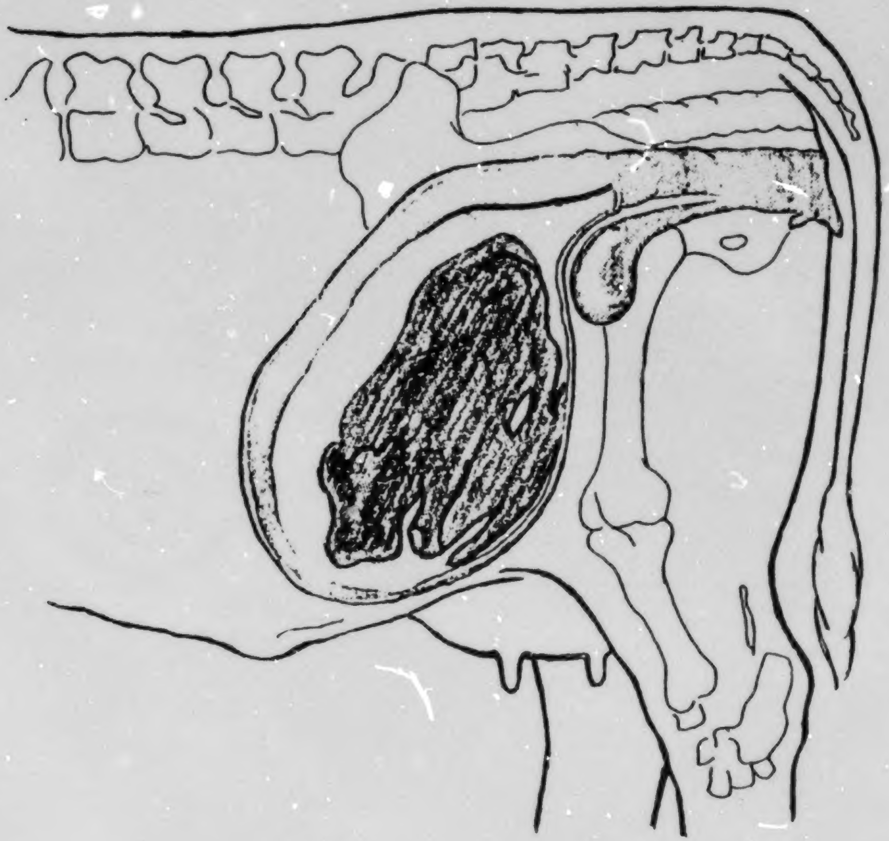
3.



attachment of zygote to wall of uteran horn

NORMAL POSITION OF FETUS

AgIII-III-44



TM-6

216

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 3: Breeding Systems (2 hrs.)

Note: All terms underlined are included in the "Glossary of Terms."

1. Livestock Breeding

Contrary to the belief of many, there are only two systems of breeding livestock, straight-breeding and outbreeding. Straight-breeding is the mating of animals of the same breed, while outbreeding is the mating of unrelated animals. Terms often used in describing a method of breeding are topcross, topincross, incross, and topcrossbred, and incrossbred.

Transparency No. 1

There are several methods of straight-breeding: inbreeding, linebreeding, purebred breeding, and up grading; but there is only one method of outbreeding, which is called crossbreeding. There are, however, several ways of crossbreeding which will be explained later.

There is not any one system or method of breeding livestock that will fit all producers, and the purpose of any system is to improve the offsprings and increase production efficiency. All breeds and crosses have desirable as well as undesirable characteristics. The producer should consider several factors in selecting the system and method of breeding he will use. Some factors to consider are as follows:

a. Climatic conditions - Some breeds and crosses are more adaptable to certain weather conditions than others.

b. Type of breeder - The commercial breeder would use a different system from the one used by the breeder of purebreds.

c. Personal preference - A breeder's personal preference will certainly influence the breeding system he will use.

d. Markets - The location and type of market on which the producer will sell his livestock should influence his selection of a breeding system.

e. The producer's knowledge of genetics.

f. Area in which the producer lives.

g. Size of operation.

h. Age of animals when they are sold.

i. Financing available.

j. Goals of the producer.

Regardless of the breeding system selected, a breeder must be able to recognize the weaknesses in this herd and be able to overcome these weaknesses by selection.

2. Breeding Systems

The method of breeding straight-bred animals will be explained in the following paragraphs.

Inbreeding - Inbred animals have closely related ancestors on both sides, within the first four or five generations.

Inbreeding does have some positive points if conducted under proper management. Positive inbreeding purposes are as follows:

a. To form families

b. To produce seed stock

c. To develop lines for crossing

d. To determine the genetic value of an individual

The commercial breeder should have an understanding of genetics and the principles of breeding before attempting any inbreeding.

Disadvantages of inbreeding are as follows:

a. Decreases reproduction

b. Decreases vigor

c. Decreases survival rate

d. Decreases growth rate

The above transparency shows the different matings that may be used for inbreeding and the amount of inbreeding in the offsprings from such matings. Production efficiency of animals with 6.25 percent or less of inbreeding is usually not affected.

Linebreeding - This is a less intense form of inbreeding used to maintain and further improve by selection high quality animals. Linebreeding does not offer the possibility of improvement nor regression that inbreeding does. Breeders who practice linebreeding usually mate animals that are both related to an outstanding animal, but they never breed animals that are closer than half brothers to half sisters. Some methods of linebreeding are as follows:

Selected bull X half sister
Son of bull above X daughters of dam above

Some very popular blood lines have been developed using the above methods of breeding. A breeder who is using linebreeding should start with good individuals and mate the best of recent ancestors. Linebreeding is successful only in herds that have a high degree of excellence and outstanding individuals as indicated by progeny tests.

Most linebreeding is practiced where the outstanding individual is not available for breeding purposes. If the individual is available, he should be bred to as many nonrelated animals as possible to spread his characteristics.

Linebreeding should be practiced only by those who recognize its potentialities and limitations and those who are knowledgeable in the principles of breeding.

Purebreeding - This is the mating of animals of the same breed which are registered by a breed association or are eligible for registry. A breed association is a group of breeders who have organized for the purpose of recording the lineage of their animals, keeping the breed pure, and promoting their animals or the breed. A purebred animal's lineage can be traced to the original foundation animals of the breed which were first accepted for registry. In a few instances, breed associations have allowed the blood from certain animals or breed of animals to be infused into their registered animals.

One should not become confused by the word purebred. This does not necessarily guarantee that an animal is superior in any way. However, the average purebred animal is usually superior in many respects to the grade animal.

The business of raising purebred livestock is for those individuals who have adequate capital and a knowledge of breeding livestock or are able to hire someone with the knowledge. Very few purebred breeders receive a great return on their investment; however, there will always be a need for purebred animals for crossbreeding and up grading of commercial animals.

Up Grading - Up grading is the mating of purebred sires to commercial cows. The purpose of up grading is to improve quality, develop uniformity, and increase performance in the offsprings. A breeder using this method should expect his herd to improve through the fourth generation. By this time, his herd will carry about ninety-four percent pureblood or breeding of the sire.

Crossbreeding - As was previously stated, crossbreeding is the only method of outbreeding. Many purebred breeders and others have criticized the crossbreeding of livestock. This has possibly been because they have not understood the benefits derived from this method of breeding. A successful crossbreeding program, the breeding of two different breeds, will include the use of purebred breeding stock.

The two principal reasons for crossbreeding are to combine the desirable characteristics of two or more purebreeds to form a new breed or type which will have greater adaptability, and to produce hybrid vigor. Although new breeds have been developed by this method, few producers are interested in developing a new breed. The advantages of crossbreeding are as follows:

a. Weaknesses can be eliminated by breeding an animal strong in a character to animals that possess a weakness for the character

b. It increases the average productivity of either parent

c. Crossbreds are more fertile

d. Crossbreeds wean heavier offsprings

e. Crossbreeds are more vigorous

The degree of heterosis is determined by the genetic make-up of the breeds crossed, and the wider the genetic background of the animals crossed, the greater the amount of heterosis. Likewise, the closer the relationship of the animals mated, the greater the depression of heterosis in the offsprings. However, the genetic ability of animals is not determined by the breeds alone; it can be increased by crossing lines within a breed. A producer should remember that animals of inbred lines show a low degree of heterosis when mated to other breeds.

The level of heterosis varies from one trait to another, and those characteristics that are highly heritable and show a strong response to selection within a purebreed do not show a noticeable response in crossing. Low hertiability traits respond poorly to purebreeding but have a high level of response to crossing. The livestock producer contemplating the crossbreeding of his livestock should be familiar with the heritability estimates of various traits.

Transparency No. 3

The level of heritability of traits in crossbred animals varies from low to high. Some traits such as tenderness of the ribeye area are highly heritable, while other traits show very little response to crossbreeding.

Transparency Nos. 4a and 4b

Although the comparison of certain traits in the above transparencies pertains to cattle, a similar comparison could be made of the traits of other classes of livestock. Figure 1 compares the reproductive performance of Herefords, Brahmans, F1s and Herefords, F1s and Brahmans, and the second crosses and Santa Gertrudis. The offsprings from either the F1 cows bred to Herefords or Brahmans were superior to the purebreds and the Santa Gertrudis and second crosses.

Figure 2 shows the yields of milk and percent advantage of the crosses over the purebreds.

Figure 3 compares the percent lost from conception to birth and birth to weaning of the purebreds and different crosses. The F1 crossed on either the Herefords or Brahmans are also superior in these areas.

Transparency No. 5

The gains of the F1 calves were ten percent greater than the average of the two parent breeds. F2 calves produced by mating F1 to F1 decreased in hybrid vigor, as is indicated by the decrease in average daily gains.

In order to maintain the many advantages of crossbreeding in his herd, the livestock producer must follow a systematic breeding program. Two methods of mating that may be used in maintaining a successful crossbreeding program are the criss-crossing and rotational breeding.

Transparency Nos. 6a and 6b

Two methods of crossbreeding are shown in the above transparencies. There are other ways of crossbreeding. The breeder should select the method that is best suited to his operation.

Using the criss-cross method of crossbreeding, the breeder should divide his F1 females into two breeding herds. Bulls, breed A, are mated to herd one, F1 females; and Bulls, breed B, are mated to herd two, F1 females. Each herd provides replacements for the other. Some hybrid vigor is lost by using the backcross method described above.

The three-breed rotational plant for crossbreeding is possibly the best, since maximum vigor is maintained. The breeds used to develop the F1 should be distinctly different. This system can be used very successfully by breeders who maintain three or more herds. For example:

Herd 1

Bulls	Cows			
Breed A	Breed	A	B	C
		14%	29%	57%

Calves

Bulls -- Go to market
Heifers -- Replacements to herd 2, excess to market

Herd 2

Bulls	Cows			
Breed B	Breed	B	C	A
		14%	29%	57%

Calves

Bulls -- Go to market
Heifers -- Replacements to herd 3, excess to market

Herd 3

Bulls	Cows			
Breed C	Breed	C	A	B
		14%	29%	57%

Calves

Bulls -- Go to market
Heifers -- Replacements for herd 1, excess to market

Up until now, only the advantages of crossbreeding have been mentioned. Not every livestock producer should crossbreed. It is not a substitute for good management. If a producer does not have a problem in any of the areas of productions (growth rate, fertility, mothering ability, mortality, and general vigor) there is not any reason why he should crossbreed. Some disadvantages of crossbreeding are as follows:

a. Crossbred cattle are discounted on some markets; however, this prejudice is being overcome

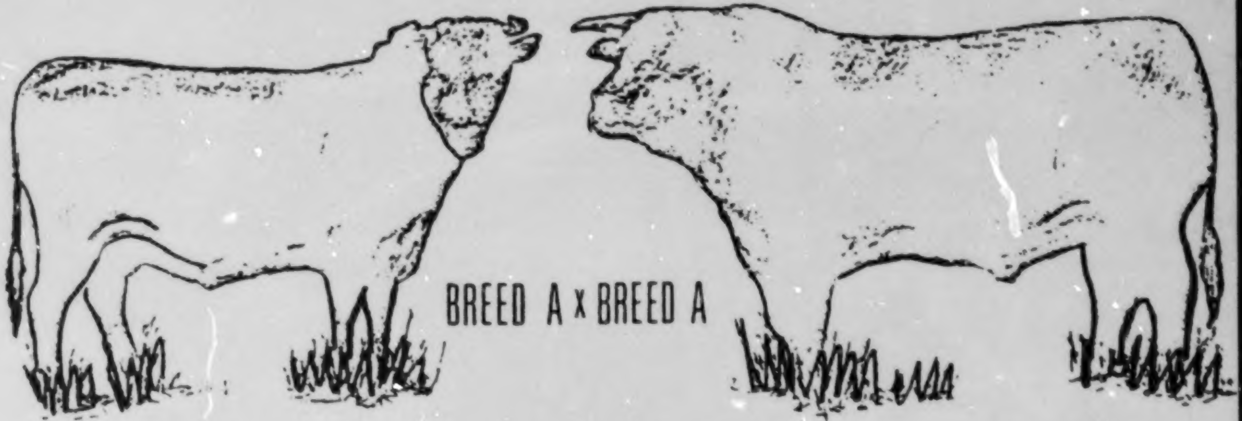
b. Several pastures are needed

c. Replacement heifers are needed

d. Selection is more difficult

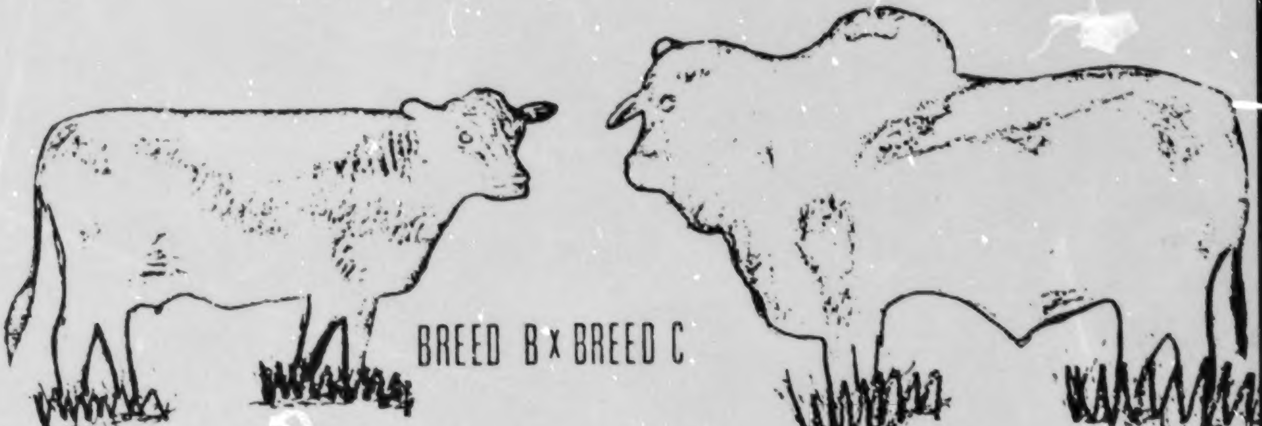
AgIII-III-52

SYSTEMS OF BREEDING


BREED A x BREED A

1 STRAIGHTBREEDING

- INBREEDING
- LINEBREEDING
- UP-GRADING


BREED B x BREED C

2 OUTBREEDING (Crossbreeding)

AgIII-III-54

TRAITS AND THEIR LEVEL OF HERITABILITY

TRAIT	LEVEL OF HERITABILITY
REPRODUCTIVE PERFORMANCE....	LOW to MODERATE
WEANING WEIGHT..................	MODERATE
COW MATERNAL ABILITY..........	MODERATE
FEEDLOT GAIN.....................	MODERATE+
CARCASS GRADE..................	MODERATE+
FEED EFFICIENCY.................	MODERATE+
RIBEYE AREA.......................	HIGH+
TENDERNESS.......................	HIGH
FAT THICKNESS....................	MODERATE
CARCASS YIELD....................	MODERATE
YIELD OF RETAIL CUTS............	MODERATE
CANCER EYE SUSCEPTIBILITY.....	MODERATE
EYE LID PIGMENTATION...........	HIGH

LOW=less than 30%

MODERATE=30-50% HIGH=greater than 50%

TM-3

A COMPARISON OF SEVERAL TRAITS OF PURCHASED AND CROSSBRED CATTLE

FIGURE 1.

	BREED OR CROSS OF DAM AND SIRE				
	H×H	B×B	F_1×H	F_1×B	SECONDCROSS×SG
% PREGNANT	89.3	78.6	91.7	95.7	71.4
% CALVED	82.1	71.4	86.4	91.3	71.4
% WEANED	78.6	42.9	70.8	86.9	71.4

FIGURE 2.

BREED OR CROSS OF COW	MILK YIELD, Lb.*	PERCENT ADVANTAGE OVER			
		H	B	H&B	SECONDCROSS
HEREFORD	7.4				
BRAHMAN	7.6				
AVE. OF H&B	7.5				
SECONDCROSS (½A×¼B×¼H)	12.8	73	68	71	
F_1 (½B×½H)	13.4	81	76	79	5
AVERAGE	13.1			75	

*Uncorrected for age of cow.

H - HEREFORD A - ANGUS B - BRAHMAN

SG - SANTA GERTRUDIS

AgIII-III-55

TM-4

A COMPARISON OF TRAITS OF PUREBRED AND CROSSBRED CATTLE

AgIII-III-56

FIGURE 3.

MATING INVOLVED SIRE×DAM	PERCENT LOST		
	CONCEPTION TO BIRTH*	BIRTH TO WEANING**	TOTAL
B×B	3.0	20.5	23.5
H×H	2.1	2.2	4.3
B×H	0.0	4.0	4.0
H×B	0.0	4.7	4.7
B×(½B×½H)	0.0	0.0	0.0
H×(½B×½H)	0.0	0.0	0.0
A×(½B×½H)	0.9	0.9	1.8
A×(½A×¼B×¼H)	0.0	0.0	0.0

*=Calves lost as percent of cows pregnant

**=Calves lost as percent of cows that calved

H - HEREFORD A - ANGUS B - BRAHMAN

TM-5

FEEDLOT RESEARCH OF PUREBREDS AND CROSSBREDS

FEEDLOT GAIN - 140 DAY TEST

BREEDING OF			AVE. DAILY GAIN, Lb.	ADVANTAGE FOR CROSSBREEDS
SIRE	DAM	CALVES		
H	H	H	2.36	(2.20 BASEPOINT)
B	B	B	2.04	
H	B	F_1	2.43	10%
B	H	F_1	2.44	10%
F_1	F_1	F_2	2.16	3% LOSS

H - HEREFORD

B - BRAHMAN

F_1 - (½H×½B)

TM-6

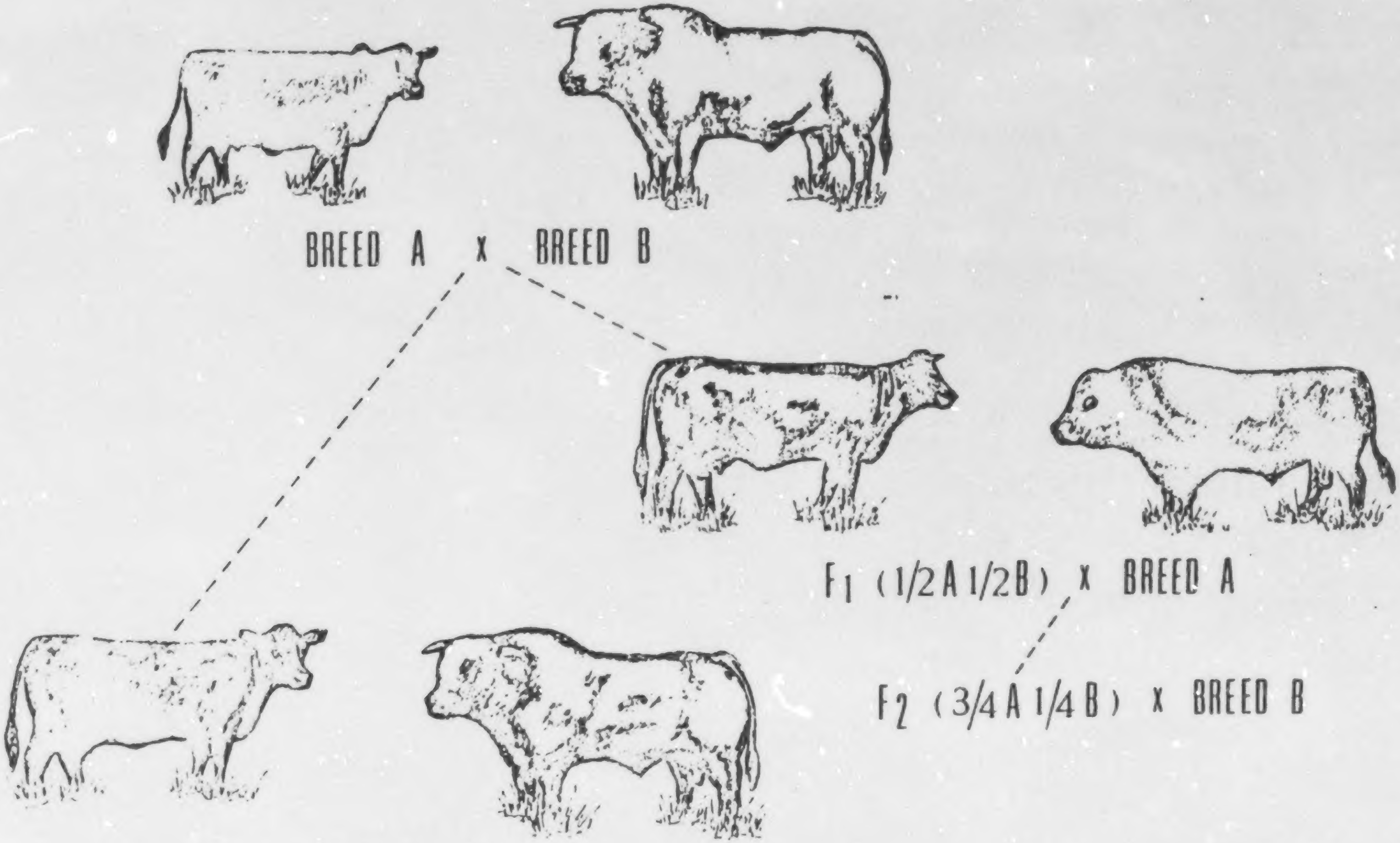
AgIII-III-57

231

232

CROSSBREEDING (Criss-Cross Method)

AgIII-III-58



BREED A x BREED B

F1 (1/2A 1/2B) x BREED A

F2 (3/4A 1/4B) x BREED B

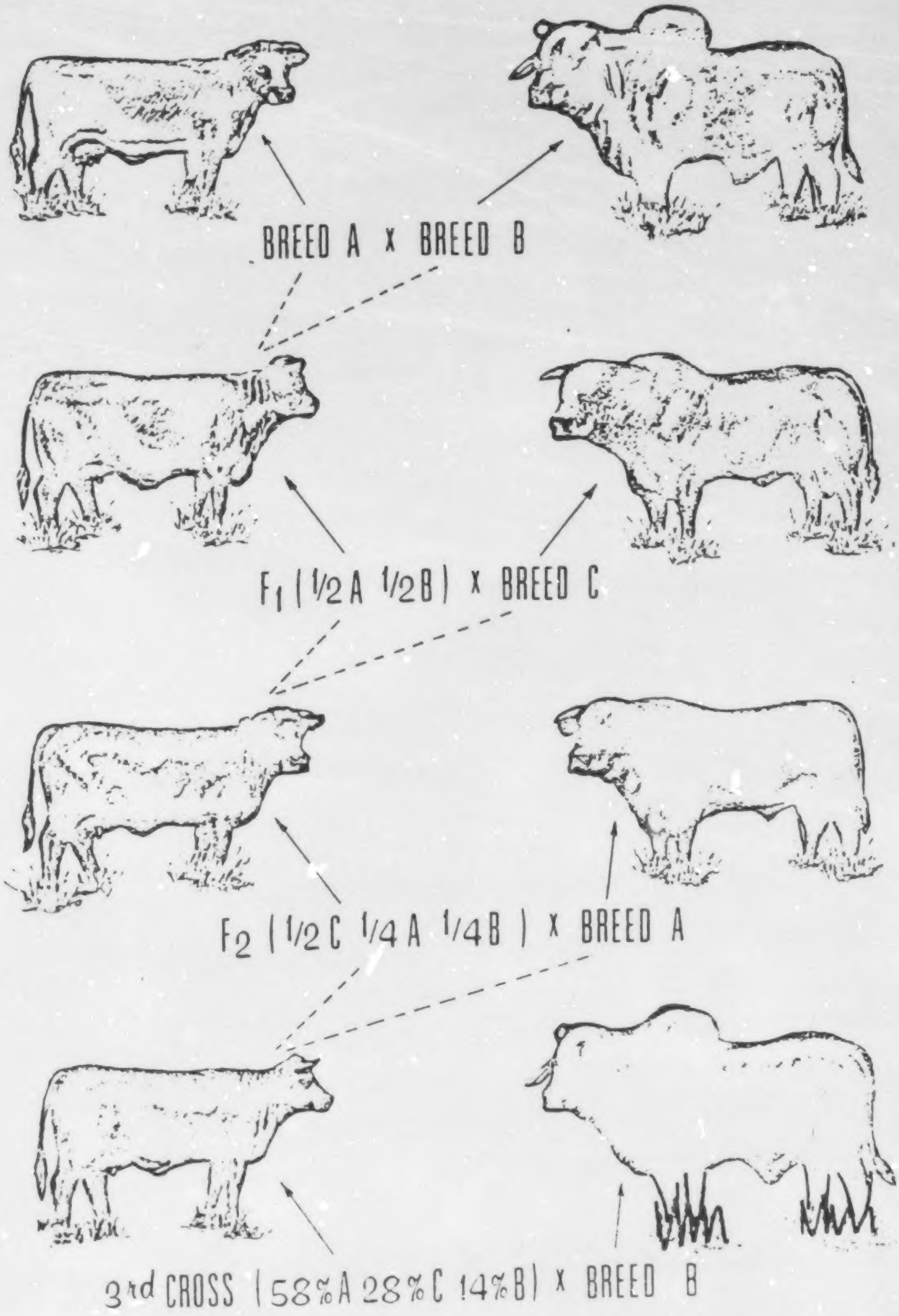
F1 (1/2A 1/2B) x BREED B

F2 (1/4A 3/4B) x BREED A

TM-6a

233

CROSSBREEDING
(Three-Breed Rotational Cross Method)


BREED A x BREED B
F$_1$ (1/2 A 1/2 B) x BREED C
F$_2$ (1/2 C 1/4 A 1/4 B) x BREED A
3rd CROSS (58% A 28% C 14% B) x BREED B

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 4: Methods of Breeding (1 hr.)

Note: All terms underlined are included in the "Glossary of Terms."

1. Selecting a Breeding Season

In selecting breeding seasons, many factors must be taken into consideration. The importance of these factors may vary considerably from one class of livestock to another. The successful farmer plans and selects that breeding season which best fits his individual needs.

Transparency No. 1

Some of the more common factors to consider in the selection of livestock breeding seasons are:

a. Amount and cost of the available labor supply
b. Feed supply and price
c. Climatic conditions
d. Type and expense of equipment
e. Availability of good pasture
f. Purpose for which the livestock is produced
    1) Commercial herd
    2) Purebred breeder
    3) Meat production
    4) Milk production
    5) Dual purpose herd
    6) Egg production
g. Livestock show exhibition
h. Available market

2. Preparation for Breeding

Preparation for breeding is essential to most classes of livestock to insure a maximum conception rate among bred females. Cattle are relatively easy to prepare for breeding, requiring only plenty of good pasture, water, minerals and some supplemental feeding. However, if a cow is not supplied all these essentials, she may not conceive after the first breeding, and will require costly and time-consuming re-breeding.

Preparation of Ewes for Breeding

Two to eight weeks before breeding, ewes should be flushed with good, lush pasture or extra grain. This increases lamb chops by 15 to 20 percent through increased conception rates and the greater occurrence of twinning. Flushed ewes tend to breed earlier and to lamb at more uniform time.

Heavy locks of wool, manure and other foreign matter should be clipped from around the dock. This wool with foreign material imbedded in it is know as tags, and the process is called tagging. This should be accomplished prior to the breeding season, as these tags may prevent the ram from breeding the ewe. In addition, tagging helps prevent wool worms caused by high moisture levels in the wool. Plenty of water and minerals should be supplied at all times.

Preparation of Rams for Mating

Shearing rams before the breeding seasons tends to make them more aggressive; therefore, this is becoming standard procedure. Warm weather tends to make sale rams and the old show rams less active. If complete shearing is impractical, the wool should at least be clipped from the belly, neck and penis region. Also, the hoofs should be trimmed properly before the breeding season. As always, proper amounts of clean water and minerals should be made available at all times.

Marking the Ram

In order to identify the bred ewes and the time of breeding, it is desirable to use a marking harness which is strapped to the ram's chest. Time of breeding may be reliably estimated by changing colors of the chalk in the marking harness periodically.

An acceptable alternative to the harness is the use of a thick paste smeared on the brisket area of the ram. This paste must be replenished at least every other day in order to insure clear marking of the ewe's rump. Tar or paint should never be used because it tends to stain and ruin the wool.

The color of the paste or crayon should be changed every estrus cycle (16 days) in order to find ewes that are coming back in heat and require re-breeding. Also, this is an ideal method of checking for non-breeding females and sterile males.

Thick lubricating oil and paint tinting colors make good paste. Yellow ochre, venetian red and lamp black make good tints to give the paste different colors. The common procedure is to start with light colors and use progressively darker colors as the breeding season continues. If a large number of ewes fail to breed, the ram should be under suspicion. He may be replaced with another ram, or in the case of valuable animals, he may be fertility tested. Temporary sterility may be brought about by lack of exercise or improper conditioning.

Preparing Sows and Boars for Breeding

Sows should be flushed one to two weeks before breeding. This practice insures more profitable litters by: (1) causing more eggs to be released, and hence, larger litters, (2) the sows are more certain to conceive when bred, and (3) they tend to come into estrus more readily. Sows of normal weight should have their daily feed intake increased so that they gain about 1 to 1½ pounds daily. Plenty of lush pasture and exercise should be made available for overweight sows, while the concentrate ratio is decreased. As always, provide plenty of clean water and minerals.

Boars should have free access to well-fenced pasture of about ¼ acre to provide exercise needed for sperm production. Overfat boars and very thin boars are usually poor breeders. They must be kept in a thrifty and vigorous condition in order to be virile, potent breeders.

Breeding Preparation for Mare

Provide proper and adequate amounts of feed for the mare, along with plenty of exercise. Always check the mare for any signs of venereal diseases, sickness or other unsoundness before breeding. Also, be certain that the mare is in standing heat, the only time she will accept the male.

If possible, the mare should be taken to the stallion for service. The foal should be taken along if the mare is to be gone over five or six hours. If necessary, milk the mare by hand. Allow the mare to become quiet and settled before service. Overheated or excited mares should be cooled before breeding. Always be certain the mare is in heat and is ready for service. The mare may be teased by tying a stallion on the opposite side of a breeding partition. After teasing, clean the stallion's penis and sheath area with castile soap and warm water, and rinse with clean water. Cotton is preferable to a sponge for cleaning.

The mare's tail should be wrapped with a clean, inexpensive cloth or gauze in order to keep the stallion's penis clean, and to keep tail hair from interfering with breeding. Only the upper six to eight inches need to be wrapped. Next, wash the external portion of the mare's reproduction system, similar to that done to the stallion. Always use hobbles and a twitch for the mare. This allows greater control of the mare. The twitch may be removed while mating is taking place. Allow the stallion to mount the mare only when he is ready for service. After mating, return the stallion to his stall or pen. Allow the mare to remain quiet for a short time after service. Any undue exertion or excitement should be avoided. Feed the mare the same ration as before breeding. If the mare does not successfully breed, she will come back in heat in approximately 21 days and may be re-bred.

Stallion Care and Management for Breeding

The stallion should have access to a roomy box stall which opens into a pasture paddock of about 2-3 acres in size. The stallion should be separated from the mares by a double horse-proof fence.

Provide plenty of water and feed to meet the stallion's needs. He should be exercised each day.

Transparency No. 2

3. Systems of Mating

Hand Mating - This breeding system involves keeping males separated from the females until breeding time. The female is then put with the male, usually for one service only. This system allows the male to serve more females and makes it easier to keep more accurate records. This method may be used for all classes of livestock and poultry.

Pasture Mating - This system allows the males to be with the females throughout the breeding season or throughout the year if desired. If uniformity in size and time of partuition are of importance, males must be limited to a breeding season rather than yearly. Nearly all commercial herds use this breeding method. Records for registered herds are more difficult to keep when more than one male is used for pasture mating. Where exact records are desired, use the recommended number of females per male, and keep them in separate pastures. This system may be used for all classes of livestock and for poultry.

Corral Mating - This system is utilized mostly by horse breeders, and entails putting the mare and stallion together in a well-fenced corral. Both mare and stallion are returned to their pens after service.

Stud Mating - This method is similar to hand mating, and may also be used by poultry breeders. The male and female are allowed to breed individually in a pen or coop.

Flock Mating - This system is similar to pasture mating where the optimum number of females for each male are placed together.

Pen Mating - This is primarily used by poultry breeders. One male is placed with a pen of hens, consisting of 8-20 hens depending on whether they are light, general-purpose or heavy breeds.

Artificial Insemination - This breeding method has recently become more popular. It may be used on dairy and beef cattle as well as poultry. Horses, sheep and swine may be artificially bred, but use of A.I. on these animals is not widespread at present. This method consists of depositing male semen in the female reproductive tract by artificial means. It has numerous advantages, and promises to become more popular with time.

Mating guides are necessary to insure good result from a breeding program, provided the sires are in good condition. A suggested male-female ratio is listed as a guide.

The following tranparencies illustrate mating guides for the various breeds of livestock.

Transparency No. 3 - Mating Guide for Poultry

Transparency No. 4 - Mating Guide for Horses

Transparency No. 5 - Mating Guide for Swine

Transparency No. 6 - Mating Guide for Sheep

Transparency No. 7 - Mating Guide for Beef Cattle

MAJOR FACTORS FOR SELECTING BREEDING SEASONS IN LIVESTOCK AND POULTRY

AMOUNT AND COST OF AVAILABLE LABOR

SUPPLY AND PRICE OF FEED

CLIMATIC CONDITIONS

TYPE OF EQUIPMENT

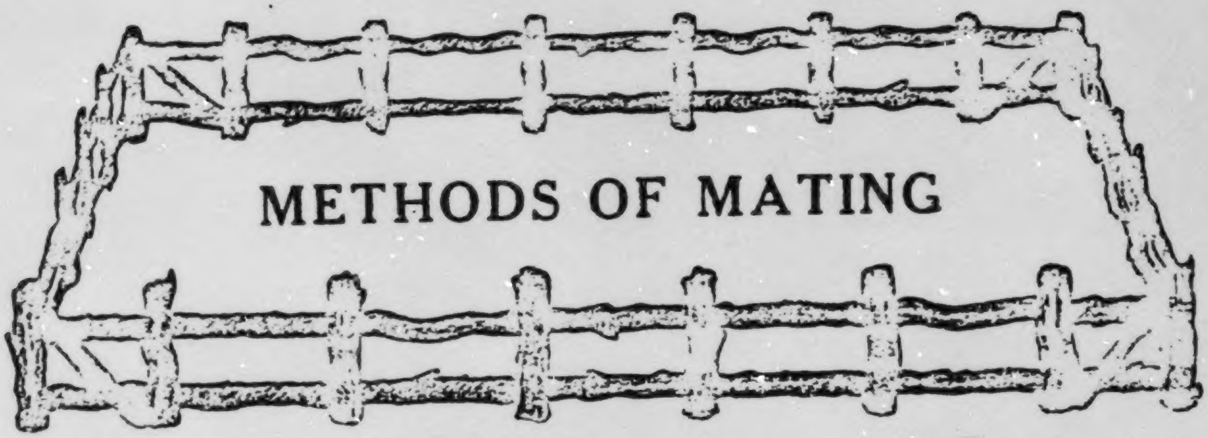
AVAILABLE PASTURE

PURPOSE OF PRODUCING LIVESTOCK AND POULTRY

- PUREBRED BREEDER
- COMMERCIAL HERD
- DUAL-PURPOSE HERD
- MEAT PRODUCTION
- MILK PRODUCTION
- EGG PRODUCTION

LIVESTOCK SHOW EXHIBITION

MARKET DEMAND



METHODS OF MATING

HAND MATING

PASTURE MATING

CORRAL MATING

STUD MATING

FLOCK MATING

PEN MATING

ARTIFICIAL INSEMINATION

MATING GUIDE FOR POULTRY

SIZE OF BIRDS	FLOCK MATING NO. HENS/MALE	COMMENTS:
LIGHT BREEDS (Leghorns, etc.)	15-20	Males 3 years and over are not good breeders.
GENERAL PURPOSE BREEDS (White Wyandotte, etc.)	10-15	
HEAVY BREEDS (Rhode Island Red, etc.)	8-12	

MATING GUIDE FOR HORSES

AgIII-III-70

HAND MATING ONLY MATINGS/YEAR	STALLION AGE IN YEARS
10-15	2-3
20-40	3-4
30-60	4-5
80-100	5-18
20-40	over 18

Pasture mating not recommended

TM-4

MATING GUIDE FOR SWINE

MATINGS PER YEAR		
HAND MATING	PASTURE MATING	AGE OF BOAR
24	12	8-12 MONTHS
50	35-40	1 YEAR OR OLDER

AgIII-III-71

TM-5

LIMIT SERVICE TO 1 PER DAY FOR YOUNG BOAR AND 2 SERVICES FOR OLDER BOAR.

MATING GUIDE FOR SHEEP

AgIII-III-72

MATINGS PER YEAR		AGE OF RAM
HAND MATING	PASTURE MATING	
20-25	NONE	LAMB
50-75	35-60	1 YEAR OR OLDER

FOR EVERY 25 TO 35 EWES, USE 1 RAM ON RANGE CONDITIONS.

MATING GUIDE FOR BEEF CATTLE

MATINGS PER YEAR		AGE OF BULL
HAND MATING	PASTURE MATING	
10-12	8-10	1-2 YEARS
25-30	20-25	2-3 YEARS
40-50	25-40	3 YEARS AND OLDER

251 ON RANGE CONDITIONS USE 1 BULL FOR ABOUT EVERY 25 FEMALES.

252

AgIII-III-73

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 5: Breeding Livestock (1 hr.)

1. Breeding Livestock

Many factors may influence reproduction in farm animals. The process of reproduction is a complicated one, especially in the female. Each factor must be correctly related to the total process in order for the female to conceive.

Early care and feeding of the young animals has a direct bearing on future reproduction. Puberty can be delayed, which in turn may cause a delay in a planned breeding season. The reproductive organs grow and develop as the animal increases in body size; therefore, proper care is essential. Any delay in growth will slow the onset of puberty, and delay the breeding age of the animal.

2. Age of Puberty for the Different Classes of Livestock

Transparency No. 1

Certain physiological mechanisms which affect puberty are influenced by heredity and nature. The season of birth, temperature, nutrition and genetic factors play an important role in controlling the onset of puberty. Animals are not always bred when they first reach puberty. It is often desirable to allow them time to mature past the initiation of puberty.

3. Breeding Ages for Females

Breeding ages will vary according to the development of the various animals within a breed. The farmer must consider the minimum breeding age established by each association dealing with that particular breed, especially if the animal is to be registered. It is often advantageous to breed at a rather early age in order to reduce production expenses. However, sometimes it is to the farmer's advantage to delay breeding so the dam may reach a larger body size.

Some suggested breeding ages for females are listed as follows:

Transparency No. 2

Heifers - The proper breeding age for heifers may very widely depending upon body growth and development. Generally, they should be bred at fifteen to twenty months of age and at a weight of 650 to 700 pounds. Some producers use Angus bulls for first calf heifers to avoid calving difficulty. Adding concentrates to the ration or wintering them on good pastures will cause heifers to breed earlier.

Gilts - A gilt must have a well-developed body to withstand the strain of lactation. Their bodies are usually developed enough for breeding at eight to ten months of age. They should weigh approximately 225 pounds.

Ewes - Ewes should be bred the first season after they are one year old so they will lamb when approximately two years old. Some farmers breed ewes to lamb as early as twelve months, but this practice is not recommended.

Does (goats) - The breeding age for does is similar to that for ewes. They should be bred to kid when the does reach two years of age.

Mares - Well developed fillies may be bred as early as two years of age. If bred at this age, they may foal at three years old. However, the safest practice is to withhold breeding until the mares reach three years of age so that they will foal as a four year old.

4. Reproductive Cycle of Livestock

Transparency No. 3

The reproductive cycle of the females of various breeds of livestock consists of (1) the duration of the heat (estrus) period, (2) the duration of the heat interval, (3) the time of ovulation in relation to heat, and (4) the gestation period for pregnant females. Other tables are available which indicate the approximate date of birth in relation to the date of breeding.

5. Breeding Ages for Males

Breeding ages for males are not as important as for females. The primary consideration is the number and quality of offsprings that the male can sire in a given season. The total number of services that should be allowed will vary according to the age, development, health, temperament, breeding condition, breeding system (hand or pasture mating) and distribution of services.

Pasture mating entails several other important factors such as range carrying capacity, size of area, and herd size. Even though the exact number of females that can be served by a male is impossible to predict, general practices followed by good livestock producers do not vary significantly. The mature bull can serve 25-40 cows on pasture mating systems and 40-50 cows under hand mating systems, with one bull to about 25 cows being the standard number for range conditions. There is a variance between breeds, but bulls should be ready for service at 18-24 months of age. Smaller breeds usually become ready for service at an earlier age than larger breeds. Testosterone production in the male causes the stoppage of growth in the long bones and, therefore, the smaller size of early maturing bulls.

The ram may be entered into a breeding program at 12-20 months of age. Usually, the ram can breed 50-75 ewes under hand mating conditions, and 36-60 ewes under pasture mating conditions. One ram to 25-35 ewes is most often practiced under range conditions.

Boars may begin breeding at 8-9 months of age. At this time they should be capable of breeding 25-50 sows under hand mating practices, and 35-40 sows in a pasture mating program. Mature boars (one year and older) are capable of breeding considerably more sows than are young boars.

Stallions vary a great deal in their breeding capacity with regard to age. Two year old stallions may breed 10-15 mares, three year olds, 30-40 mares; 4 year olds, 40-60 mares; mature stallions, 80-100 mares; and over 18 years old, 20-40 mares. Stallions should not be allowed to pasture mate because of the possibility of injury.

6. Breeding Defects

Lethal characters, which are hereditary factors, may be passed from parents to young at conception and may cause death at any time of the offspring's life. If the lethal gene does not cause death, it may cause the young animal to be unprofitable. Animals deploying these undesirable traits should not be kept. Some breeding defects of different degrees of severity are listed below.

a. Crooked legs or neck
b. Cancer eye in cattle (partially inherited)
c. Twisted nose
d. Mission dew claw
e. Tailless
f. Dwarfism and bulldog calf
g. Brain hernia

h. Genital abnormalities
   1. Scrotal hernia
   2. Vaginal and uterine prolapse
   3. Malformed penis
   4. Incomplete descent of testes

i. Single toe or "male foot"

j. Extra legs

k. Line backs in registered Hereford cattle

l. Horns, buttons or scurs in registered polled animals

m. Color of skin or hair not characteristic of breed in registered livestock

n. Stiff-legged horses

o. Inverted nipples in swine

p. Hair swirls on registered swine

7. Breeding Seasons

Transparency No. 4

An integral part of the return of the farmer's investment is affected by the breeding season he selects and the associated calving season. A calf crop of standard weights and ages is easier to manage and commands a greater sale price than one of varied sizes and ages. For these reasons, all calves should be dropped within a 60-70 day period.

The choice of breeding season will depend on the desired season for calving. Most farmers prefer either spring or fall calves, depending on available labor and housing, desired weaning dates of calves, cost of winter feed and how the calf crop is to be handled.

There are advantages and disadvantages of choosing either season, and the choice will be influenced by local situations.

a. Advantages of Spring Calves

Transparency No. 5

(1) Spring-dropped calves normally require less housing than fall calves. (2) It is more economical to feed dry cows through the winter than those suckling calves. (3) By choosing the spring calving season, cows are allowed to graze pasture during the time of greatest feed demand, thereby reducing labor costs as well as feed costs. Also, cows produce more milk and have higher conception rates when grazing on pasture. (4) Spring calves are ready to be put on feed or sold in the fall.

b. Advantages of Fall Calves

Transparency No. 6

(1) Fall-dropped calves are weaned at a time when feeder prices are normally more favorable. (2) There is less heat and insect stress for the baby calf. (3) Closer attention must be paid the cows during winter breeding periods, but this is easier because the labor supply is more plentiful.

Generally, more livestock producers prefer the spring calves to the fall calves because feeding costs are lessened, and housing is not such a critical factor. This is especially important in colder climates.

8. Factors Affecting Breeding Season Management

The percent calf crop is the most important consideration in the cow-calf operation. One non-breeding cow can use up the profits of as many as three calves. There are three factors which are present in the successful breeding program.

a. Short breeding season
b. 100% conception rate
c. 90% weaning or marketing rate

Close attention must be paid to those cows which do not re-breed readily. Culling on the basis of breeding performance is a common and profitable practice. For example, if a cow does not return to estrus until seven weeks after calving, and does not conceive within the 60-day breeding period, the time between calves will be more than a year. On this basis, the cow would be subject to culling from the herd.

PUBERTY AGE FOR FARM ANIMALS

SPECIES	PUBERTY AGE (mo.)
SHEEP	5-8
SWINE	5-8
HORSES	12-18
CATTLE	8-14
POULTRY	5½-6½
GOATS	4-8

RECOMMENDED BREEDING AGES FOR LIVESTOCK

SPECIES	AVERAGE AGE (mo.)	
	FEMALES	MALES
CATTLE	15-20	18-24
SWINE	8-10	8-9
SHEEP	18-19	12-20
GOATS	18-19	12-20
HORSES	24-36	24-48

REPRODUCTIVE CYCLE OF LIVESTOCK

SPECIES	DURATION OF HEAT		DURATION OF HEAT INTERVAL (days)		TIME OF OVULATION IN RELATION TO HEAT	AVERAGE GESTATION PERIOD (days)
	RANGE	AVE.	RANGE	AVE.		
COW	8-30 hr.	14 hr.	18-24	21	14 hrs. AFTER END	281
SOW	1-5 da.	2-3 da.	18-24	21	NEAR END	113
EWE	1-3 da.	35 hr.	14-20	16	AT END	150
GOAT	2-3 da.	2½ da.	15-24	21	NEAR END	151
MARE	2-11 da.	6 da.	16-30	22	1 to 2 da. BEFORE END	336

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BREEDING PERIODS, CALVING PERIODS AND CORRESPONDING WEANING MONTHS

CALVES	BREEDING PERIOD	CALVING PERIOD	WEANING MONTH
SPRING CALVES	JUNE 5-AUG. 20	MAR. 15-JUNE 1	NOVEMBER
FALL CALVES	NOV. 20-FEB. 5	SEPT. 1-NOV.15	MAY

(AVERAGE AGE-205 days)

TM-4

ADVANTAGES OF SPRING CALVES

1. LESS HOUSING REQUIRED

2. COWS REQUIRE LESS FEED IN WINTER

3. COWS HAVE ACCESS TO PASTURE DURING PERIOD OF GREATEST NEED

4. CALVES READY TO SELL OR PUT ON FEED IN FALL

ADVANTAGES OF FALL CALVES

1. FEEDER PRICES BETTER AT WEANING
2. LESS HEAT AND INSECT DAMAGE
3. CLOSER CONTACT BETWEEN THE FARMER AND HIS HERD

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 6: Care at Parturition (1 hr.)

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to Partuition

The time approaching and during parturition is a critical stage in the production cycle of livestock. By keeping accurate breeding records, the producer will be prepared to render assistance to the animal at parturition. The record may be an individual breeding record or a record of when the male(s) was placed with and taken from the herd.

Some classes of animals require more assistance at parturition than others, and producers who plan to give assistance to animals should make preparations before parturition begins. Assistance given at the proper time will save many young animals.

2. General Signs of Approaching Parturition

The exact date of parturition in animals is difficult to determine, but there are certain general signs of approaching parturition with which the livestock producer should become familiar. Some signs are more distinct in one kind of animal than in another. Several signs which indicate parturition is approaching are listed as follows:

Distended Udder - A distended udder will become noticeable two to six weeks before parturition in cows and mares. The udders of sheep do not usually become distended until ten days to two weeks before parturition.

Muscle Shrinkage - As parturition time approaches in cattle and sheep, the muscles around the pin bones and tailhead shrink and fall away. The muscle parts at the top of the buttocks shrink and fall away about seven to ten days before a mare foals.

Change in Contents of Udder - The contents of the udder of all livestock will change from a watery fluid to a heavy colostrum milk two to three days before the young animal is born. Sows will usually farrow within twenty-four hours after the milk develops in their nipples.

Vulva - The vulva of all livestock swells and becomes enlarged just prior (two to three days) to an animal's giving birth.

Wax on Ends of Teats - Wax forms on the ends of the teats of ewes and mares two to four days before parturition.

Restlessness and Nervousness - All livestock becomes restless and nervous just prior to parturition; the animal will usually separate from the rest of the herd before parturition.

Many of the signs of approaching parturition mentioned above are evident in swine. Most swine producers keep accurate breeding records and place their swine in a farrowing facility a few days before they farrow.

3. Preparing Livestock for Parturition

As parturition approaches, the pregnant animal should be moved to the quarters where they will give birth to their young. This should be several days before parturition in order that they will become accustomed to the quarters. If the weather is warm and a clean pasture is available, this is an ideal place for animals to give birth.

Preparations that should be made for parturition for several kinds of animals are explained as follows:

Cattle - Cattle have very few calving problems, and most cows are calved in pastures. During inclement weather, however, it may be necessary for the producer to provide calving stalls. The stalls should be clean, well-ventilated, and comfortable. Most cattlemen place their pregnant animals in a small pasture during the period before calving so the animals can be observed closely. The cattleman rides through the pasture two or three times a day so that he can assist any cow having calving trouble.

Swine - The farrowing house must be well-ventilated and should be thoroughly cleaned and disinfected before moving the sow into it. Heating equipment should be checked and placed in operating condition. The temperature should be maintained at 60^o to 70^oF, and the temperature should never get higher than 85^o or below 40^oF. The farrowing pen should be bedded with a light covering of bedding materials. Ground corn cob, peanut hulls, shredded fodder, wood shavings, and chopped hay may be used as bedding.

Prior to moving the sow to the farrowing quarters, she should be washed with soap and warm water; special care should be taken to thoroughly wash her sides and underline. This will remove worm eggs and other parasites which may infect the pigs.

The sow should be isolated from the herd and placed in the farrowing stall four to five days before farrowing. The sow should be given exercise and a laxative feed while confined to these quarters.

Mares - If the ground is dry, a clean pasture or paddock is an ideal place for the mare to foal. If weather conditions do not permit pasture foaling, a roomy, clean box stall away from other animals should be provided. A lye solution, 8 ozs. of lye to 20 gallons of water, may be used to disinfect the stall. The stall should be bedded with absorbent bedding materials, and all obstructions that might cause injury to the mare or foal should be removed.

A few days before the mare foals, a light, laxative feed should replace from one-third to one-half of her grain ration. Wheat bran is a laxative feed which may be substituted for the grain.

Ewes - To prepare ewes for parturition, the producer should tag them four to six weeks before lambing. Tagging is the process of shearing the wool from around the ewe's eyes and face, teats, udder, rectum, and insides of the rear legs. This prevents the young lamb from nursing a tag and starving, keeps the area around the rectum and vulva free of dung and afterbirth, makes the lamb easier for the ewe to find, and makes it easier for the ewe to eat.

The production method used by the producer will influence the method used to prepare ewes for parturition. An explanation is given of the several methods that may be used:

a. Pasture lambing - Several variations are used in lambing ewes in a pasture. One method is to allow the ewes to lamb in the pasture without assistance or any special care. Another method is to work the ewes through a cutting gate every two weeks and group the ewes that are going to lamb in a few days. These ewes are then grazed in a small lambing pasture, either permanent or temporary. The producer goes through the pasture several times a day to check the ewes. If a ewe has trouble lambing, the producer will assist her. After the lambs have been observed for five or six days, they are moved with a group of ewes and lambs requiring the same kind of care.

b. Combination Pasture and Shed - During the day the ewes graze in a pasture and are put under a shed at night. Ewes that lamb either place are separated from the flock.

c. Lambing Pens - Ewes lamb in an individual pen, or several ewes are kept in a larger pen until they lamb. After the ewes lamb, they are placed with their lambs in an individual pen.

4. Caring For the Cow at Calving Time

Normally, the only time a cow would need special care at calving time would be in extremely cold weather. First calf heifers should be watched closely should they need assistance with calving.

Transparency No. 1

If presentation of calf appears to be normal, the attendant should stay out of sight of the animal. A cow will have a calf in a normal presentation in one to two hours. If the cow has labored for some time and is laboring less frequently, the attendant should give her some assistance.

Transparency Nos. 2a and 2b

The above transparency shows several abnormal presentations. These would apply to mares and ewes.

Picture no. 1 shows both front legs bent at the knees. The legs should be extended for normal presentation.

Picture no. 2 shows an anterior presentation with the head bent backwards. The head must be straight for normal presentation. This can sometimes be accomplished by slowly pushing the fetus back.

In picture no. 3 one leg is bent backwards at the knee. For normal presentation, the attendant should place a rope around the leg that is bent backwards, push the head up, and pull the leg forward.

In picture no. 4 the hind feet are in the pelvis. The fetus must be turned so that the head, forelegs, or hind legs can be started through the pelvis.

Picture no. 5 shows a buttock presentation. The fetus should be pushed forward and the hind legs brought into the genital passage for presentation.

Picture no. 6 is a back presentation. Delivery is usually normal in this presentation but it may be necessary to assist the animal by applying traction.

When an attendant has had to assist an animal with presentation, he should wipe the mucus from the calf's nostrils; and it may be necessary to apply artificial respiration to get the young animal to start breathing. To prevent the possibility of a navel infection, the attendant should treat the young calf's navel cord with a two percent iodine solution.

Generally, the newly born calf will nurse within one-half to one hour. If the calf is weak, the attendant may have to assist the calf by holding it where it can nurse.

The cow should expel the afterbirth in three to six hours. If she has retained the afterbirth after twenty-four hours, a veterinarian should be called.

5. Caring for the Sow at Farrowing Time

It has been estimated that thirty to thirty-five percent of all baby pigs are lost at birth. The number of pigs saved can be the difference between profit and loss.

Most sows do not need assistance at farrowing time; however, the attendant should be available should the sow need assistance. After the pigs are born there are several procedures that should be followed:

a. The navel cord should be cut if the cord hinders the pig's movement.

b. Cut needle teeth. There are eight sharp needle teeth, two on the upper and lower jaw on each side of the pig's mouth. Cutting these teeth will prevent the pigs from cutting each other and the udder of the sow. Care should be taken not to injure the pig's gums. Side-cutting pliers may be used to cut the needle teeth.

c. Earnotch the pigs. Purebred breeders and some commercial swine producers notch the ears of pigs at birth. This is used to identify the pigs so as to determine the productivity of the sow.

d. Prevent anemia by providing fresh soil or by painting the sow's udder with ferrous sulfate. The mixture for the ferrous sulfate solution is 1 lb. of copperas, 1 qt. of hot water, and one cup of syrup or honey (used to improve the sticking ability). All of the copperas will not dissolve in the water.

e. Creep feed pigs at two weeks of age. Following farrowing, the sow should not receive any feed for twenty-four hours; however, she should be provided plenty of fresh water. The first feeding after farrowing should be about one-third of the sow's normal ration. The feed should be gradually increased until the sow is receiving the normal amount of feed after seven days. After the seventh day, the sow should be fed all she will eat.

6. Care for the Mare at Foaling Time

Usually mares do not experience difficulty at foaling time, but an attendant should be available. His presence may prevent injury to the mare, foal, or both. A mare with a normal presentation will foal in fifteen to thirty minutes. At the height of the labor pains, the mare usually will lie down; and it is in this position that the colt is usually born. Give the mare a reasonable length of time to foal; if she does not, assistance should be given. The attendant should follow procedures for good sanitation and be as quiet and gentle as possible.

The mare should expel the afterbirth within one to six hours after she has foaled. The attendant may wish to tie a part of the afterbirth to the mare's tail before she has expelled all of it. This will prevent her and the foal from stepping on it and possibly causing an inflammation of the uterus. If the afterbirth is retained longer than six hours, a veterinarian should be called. If lameness is evident in the mare, this is a sign of laminitis; and the mare will need treatment.

After the mare has foaled, a restricted amount of water should be made available to her periodically. The feed should be light and restricted on the first feeding after the mare has foaled.

If the mare foaled in conditions other than a clean pasture, the navel cord of the foal should be treated with a ten percent iodine solution to prevent joint-ill or navel-ill, a fatal disease in fifty percent of the cases. The iodine solution may be applied by filling a wide mouth jar, placing the foal's navel cord in the jar, and pressing the bottle against the foal's abdomen. If it is necessary to cut the foal's navel cord, it should be cut diagonally across the cord or scraped into with a knife. This prevents excessive bleeding.

The foal should be on its feet and attempting to nurse the mare within two hours after it is born. If it is weak or unable to nurse for some other reason, the attendant should assist it.

The foal should receive the colostrum milk of the mare, and if it is unable to nurse, the mare should be milked, and the milk fed to the foal. Since constipation can be fatal, the foal should have a bowel movement within twelve hours after it is born. If it appears sluggish and does not nurse, the foal should be given an enema of warm water with a little glycerin or warm soapy water. The foal should also be checked to see that it does not have diarrhea, which may be caused by the mare's milk or unsanitary conditions. If it is caused by milk, the feed given to the mare should be decreased.

7. Care of the Ewe at Lambing Time

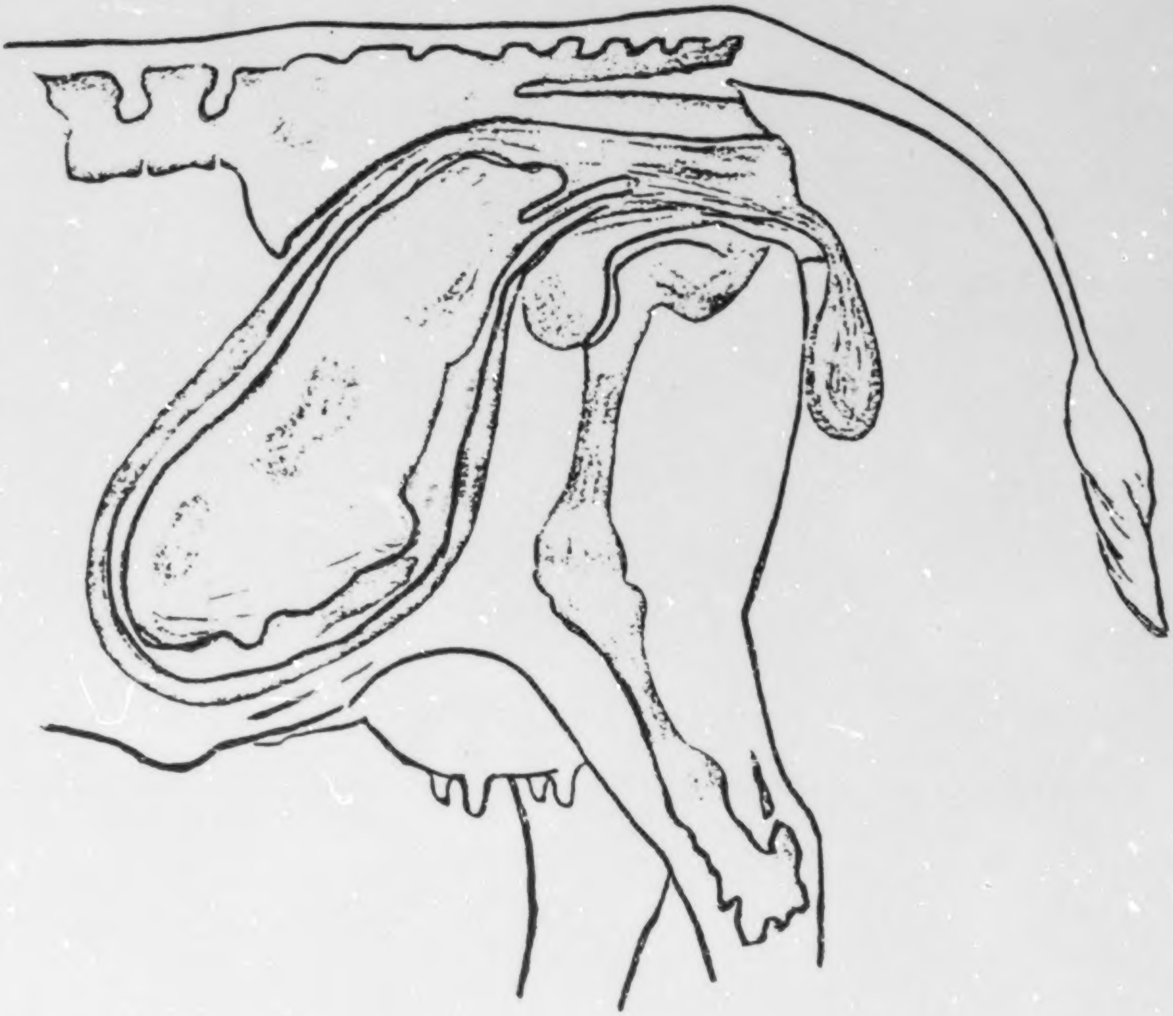
Healthy, well-fed ewes seldom have trouble lambing. The system used to lamb will determine whether the producer can give the ewe assistance should she have trouble lambing. Ewes that are lambed in a small pasture, pens, or under a shed should be observed from time to time but not bothered unless they need assistance.

If assistance is needed, the attendant should disinfect his hand and arm and apply a coating of vaseline on his hand and fore arm. He should first determine the position of the lamb and, if possible, turn the lamb to its proper position. A lamb in the normal position will be in the same position as the calf in Transparency No. 1. If the lamb cannot be placed in the proper position, it will be necessary to follow the same procedure in assisting the ewe as is suggested for assisting the cow.

After the lamb is born, it should be dried and the mucus removed from its nostrils. It may be necessary to give the lamb artifical respiration to start it breathing. In cold weather, heat should be provided.

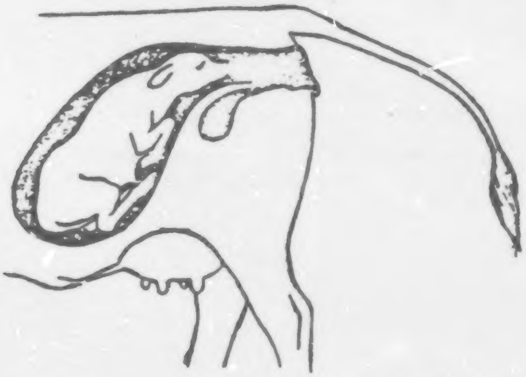
The attendant should make sure the lamb nurses, the ewe cleans herself of afterbirth, and that the ewe is not constipated. Pleanty of water and light feed should be provided for the ewe. The ewe and lamb should be observed several days to watch for possible problems.

NORMAL PRESENTATION OF CALF

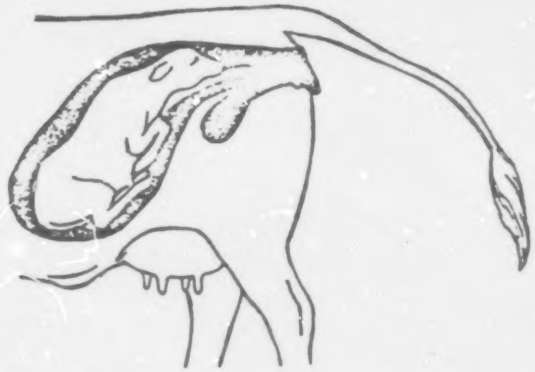


TM-1

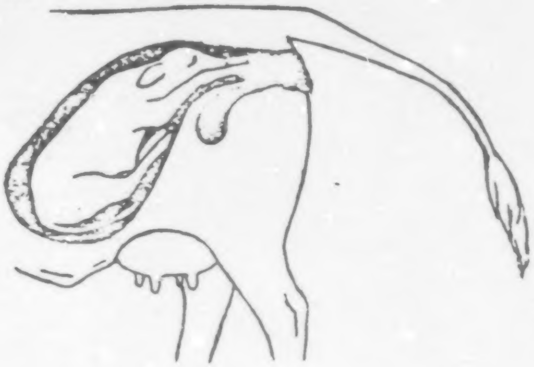
SOME ABNORMAL PRESENTATIONS OF CALVES



ANTERIOR PRESENTATION: BOTH FORELEGS BENT AT KNEES

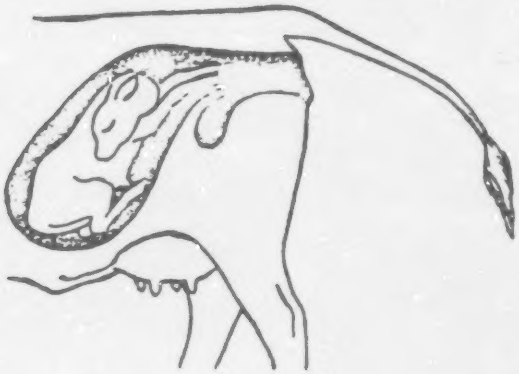


ANTERIOR PRESENTATION: ONE FORELEG BENT AT KNEE

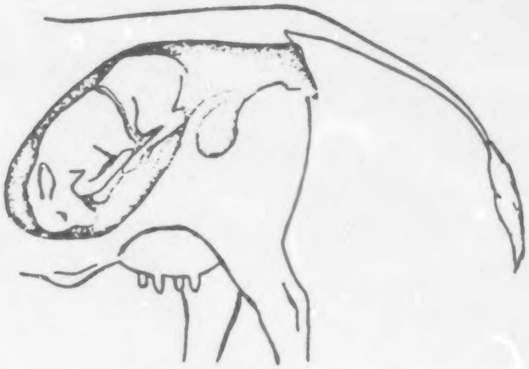


ANTERIOR PRESENTATION: HIND FEET IN PELVIS

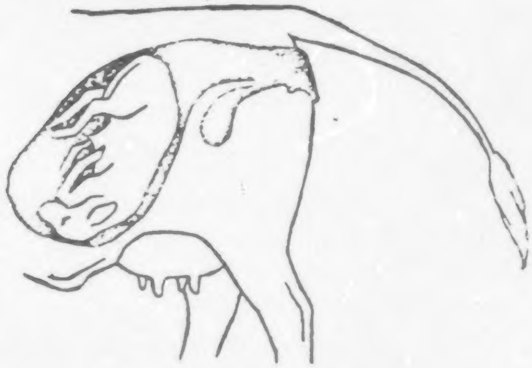
SOME ABNORMAL PRESENTATIONS OF CALVES



ANTERIOR PRESENTATION: HEAD UPWARD AND BACKWARD



BUTTOCK PRESENTATION: SHOWING FETUS CORDED



BACK PRESENTATION

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 7: Palpation (6 hrs.)

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities:

1. Introduction to Palpation

With today's high cost of cattle production, the rancher has an annual expense of from 50 to 100 dollars on every cow he owns. The cattleman pays this cost whether the cow calves or not. The following example shows the importance of a high calving rate:

Transparency No. 1

If a rancher owns 100 cows with a cost of 80 dollars per head per year and he has a 75 percent calf crop, his costs will be as follows:

$80.00 x 100 cows = $8,000 cost for one year.

If only 75 cows calved, then the 25 cows without calves cost him $2,000 and produced no return. The 75 calves must pay the $6,000 cost of maintaining their dams, as well as the $2,000 cost of maintaining the non-producing cows. As can been seen, the rancher in this case will find it difficult to make a profit.

If the rancher with the 75 percent calf crop had known which 75 cows were pregnant, he could have culled and replaced the other 25 cows and rid himself of a large portion of the $2,000 expense or loss. A technique called palpation has been developed to enable the rancher to determine which of his cows are bred. The rancher can then cull the non-breeders from his herd and rid himself of unnecessary costs that rob him of profits.

2. Equipment Necessary for Palpation

Transparency No. 2

Palpation is a relatively simple process and requires little special equipment. The following articles are necessary:

Protective Covering for the Arm and Hand - Since the palpator must insert his hand and arm into the rectum of the cow, it is necessary that he cover them. Plastic or rubber sleeves may be used for this purpose. If rubber sleeves are used, they should be dried after use and covered with talcum powder before being stored. No special care need be taken with plastic sleeves as they are disposed of after use.

Lubricant - The lubricant should be applied to the covered hand and arm to facilitate entry into the cow's rectum. Liquid soap is one of the best lubricants, because it provides a slick covering over the arm and does not irritate the cow's rectal cavity as detergents sometimes do.

Transparency No. 3

Chute - The holding chute should be constructed so that the animal can stand on the ground in a normal position. There should be a gate in front of the cow and a pipe or pole for insertion through the chute behind the animal approximately 4 inches above the hocks. The pipe keeps the palpator from being kicked and also prevents the animal from backing up. An entrance gate through the side of the chute should also be provided. It should open to the inside of the chute so that animals behind the cow being palpated can be closed off when the palpator steps into the chute to begin his work.

The animal's head should not be placed in a stanchion or headgate as this will tend to excite the cow. The floor of the chute should be dirt; but when concrete or wood flooring is used, some type of cleats or cross-slats should be constructed to prevent the cow from slipping.

3. The Reproductive System and Palpation

Determining pregnancy in cattle by palpation is not particularly difficult, but it requires experience, practice, and a thorough knowledge of the cow's reproductive system.

To accurately determine pregnancy, the palpator must insert his hand into the cow's rectum, locate the reproductive tract through the rectal wall, and determine whether a condition of pregnancy exists. Since the operation is performed completely by sense of touch, the palpator must know where all the reproductive organs are located and how they feel at different stages of pregnancy.

The location and feel of the following female reproductive organs and other body parts familiar to the palpator:

Transparency No. 4

Vulva - This is the external portion of the female reproductive tract and may be seen as two prominent lips. Although this organ is of no importance in palpation, it can be used as an indicator in the latter stages of pregnancy. During this period the vulva will become swollen and more prominent.

Vagina - The vagina is located just inside the vulva and serves as a depository for sperm during a natural service by a bull. The rear portion of the vagina serves as a common passageway for urine and the passage of young at birth. The vagina is usually the first organ felt during palpation because it is directly under the rectum. It is felt as a soft, spongy cylinder.

Cervix - This organ is located at the upper end of the vagina. It is an important "landmark" in palpation, and it is usually easy to locate because of its hard, gristly feel.

Uterus - This organ lies directly in front of the cervix. The cow's uterus is composed of two uterine horns that are connected. The fertilized egg implants itself in the wall of one of the horns, and the ovum begins to develop. The palpator can follow the two horns by beginning at the upper end of the cervix and following them to their respective ends. The horns are larger at the lower end and taper off in size toward the upper ends. The location and feel of the uterus will depend upon the stage of pregnancy and the age of the cow.

Fallopian Tubes - These small tubes are located at the upper ends of the uterine horns. They act as the passageway for the egg as it moves into one of the uterine horns.

Ovaries - The female egg develops a follicle on the ovary. The ovaries are suspended in the body cavity by ligaments attached to the top of the abdominal cavity. They are located approximately at the ends of the fallopian tubes on each side of the body cavity. In a normal cow they are about 1/2 inch wide, 3/4 inch deep, and 1 inch long and should feel firm.

Transparency Nos. 5 and 6

Pelvis - The pelvis forms a bone cradle for the open reproductive system. As pregnancy advances, the cervix and uterus move down over the pelvic ridge and into the body cavity. Because the pelvis never moves, it is an excellent "landmark" in palpation. It can be felt by pressing down through the rectal wall immediately after the palpator pushes his hand into the cow.

Embryonic Vesicles - After the fertilized ovum has moved into the uterine horn and begun to develop, it is surrounded by a fluid-filled sac. This sac causes an enlarged area in the horn.

Caruncles - The caruncles are raised prominences that line the walls of the uterus. They serve as connecting points for the fetal membranes. After connection at about 38 days, they serve as nutrient and waste exchange between the fetus and its dam.

Cotyledons - These are the "buttons" on the fetal membranes that attach themselves to the caruncles that line the uterus.

Broad Ligament - This is the support for the uterus.

Uterine Artery - This artery is the main blood supply from the dam to the developing fetus.

4. Palpation

Transparency No. 7

Palpation may be done with either hand. One hand can be used to grasp the cow's tail as leverage. The covered, lubricated hand should be shaped into a wedge by bringing the fingers close together. This will help in the initial thrust into the rectum. As the hand goes through the cow's anus, the hand should be formed into a fist to push aside fecal material and straighten the folds of the rectum.

Beginning palpators may wish to clean the fecal matter from the cow's rectum, especially if the animals have been on dry range. Cleaning the rectum will increase the sense of feel when the palpator is inexperienced.

Feeling through the rectal wall is much like feeling through a layer of thin rubber. The thickness will vary slightly with individual cows and may vary greatly between breeds. The heavier breeds, such as Santa Gertrudis and Charolais, usually have thicker rectal walls than do smaller breeds. The larger body cavity of the heavier breeds may also present difficulties in locating the reproductive tract after the palpator's hand has passed the pelvic ridge.

The palpator should locate a point of identification immediately after entering the rectum. Finding the pelvic ridge is a good place to start. If the animal is not pregnant the reproductive tract will normally lie just to the rear of the ridge. In older cows the uterine horns of the open tract may hang slightly over the pelvic ridge. As pregnancy advances and the cervix and uterus move over the ridge and into the body cavity, the palpator will have to feel past the ridge and downward.

5. Determining Stages of Pregnancy

Transparency No. 8

30-Day Pregnancy - Determining pregnancy at this early stage takes a great amount of skill and practice. Palpation at this stage should be accompanied by good breeding records so that the palpator can check the breeding dates of the animals.

In a 30-day pregnancy the uterus will be filled with fluid and feel slightly thinner. One of the horns will be enlarged a little more than the other. By running each horn between the fingers the enlargement in one horn can be felt. This enlargement is the embryonic vesicle. The vesicle is about 3/4 inch in diameter and filled tightly with fluid. It has much the same feel as a balloon filled with water. On the same side as the enlargement may be found a corpus luteum on the ovary. The corpus luteum will be a hard teat-like projection on the surface of the ovary. At this stage of pregnancy, the reproductive tract will still lie on the floor of the pelvis.

Transparency No. 9

45-Day Pregnancy - In this stage the fetus is about one inch long. The vesicle around it has become somewhat egg shaped and measures one to one and one-half inches in length. The uterine horn containing the fetus has become larger and thinner walled. The vesicle membranes are beginning to attach themselves to the caruncles on the uterine wall. Therefore the palpator should take care not to move the fetus about in the uterus. Excessive movement at this time could break the attachments and cause the death of the fetus.

Transparency No. 10

60-Day Pregnancy - The uterus has now enlarged until one horn is about the size of a banana and measure 8 to 10 inches long. The weight of the fetus and other contents has pulled the uterus over the pelvic ridge into the body cavity. The fetus measures 2 1/2 inches in length, and the embryonic vesicles are still prominent. The best method of feeling the fetus at this stage is to gently tap the uterus with your hand. This will cause the fetus to swing back and forth and bump against the embryonic vesicles and uterine walls. The bumping can be felt by the palpator. In this stage the cervix is still in the pelvic cradle, and the ovaries are suspended rather high in relation to the uterus. The corpus luteum will again be found on the ovary corresponding to the enlarged uterine horn.

Transparency No. 11

90-Day Pregnancy - The uterus in this stage is considerably larger because of increased fluid and fetal growth. The fetus is now about 6 1/2 inches long and is located on the floor of the body cavity. The cervix may be pulled over the pelvic ridge into the body cavity. The stretched uterus has pulled the ovaries down so that they may be palpated on either side of the uterus.

Because of the low position of the uterus, palpating the fetus in this stage may be difficult. The palpator may have to consider other factors to confirm pregnancy. The palpation of the uterine artery may be used to accomplish this. This artery, which carries blood to the developing fetus, is located in the forward fold of the ligament that supports the uterus. At this stage it is 1/8 to 3/16 inch in diameter and has a characteristic "whirring" pulsation as the blood moves through it. It can be felt by pressing it against the left forward side of the pelvis. Care must be taken not to confuse the femoral artery, which lies in the muscle of the thigh. To confirm the presence of the uterine artery, attempt to move it from side to side. The femoral artery cannot be moved and does not have the "whirring" pulsation of the uterine artery. Perhaps the best indication at this time (in the absence of the fetus) is the presence of the cotyledons on the uterus. They may be felt as flattened, egg shaped masses on the uterus. They will feel slightly firmer than the uterus and will measure 3/4 to 1 inch across.

Transparency No. 12

120-Day Pregnancy - The fetus in this stage is 10 to 12 inches long and is still on the floor of the body cavity. The head of the fetus is about the size of a lemon and may be the first portion of the fetus that the palpator touches. Since the fetus is larger in this stage, it is normally easier to locate. The cotyledons have enlarged to about 1 to 1 1/2 inches in length, and the uterine artery has increased in size.

Transparency No. 13

150-Day Pregnancy - The main change from this stage until birth is in the increased size of the fetus. At 150 days the fetus is the size of a large cat. The uterine artery is 1/4 to 3/8 inch in diameter, and the cotyledons are 2 to 2 1/2 inches in diameter. Palpation of the fetus may still be difficult because of its low position in the body cavity.

Transparency No. 14

180-Day Pregnancy - At this stage the fetus is still deep in the body cavity. The uterine artery is 3/8 to 1/2 inch in diameter, and the cotyledons are larger. From 180 days until birth the fetus can be made to move by grasping the feet, legs, or nose.

Transparency No. 15

Over 7-Month Pregnancy - From 7 months until calving, the fetus may be easily felt because of the increase in fetal size.

6. Areas of Confusion in Palpation

The following areas may cause the beginning palpator to become confused or miscalculate pregnancy:

The Paunch (Rumen) - This portion of the digestive tract may be felt just after the initial thrust into the rectum. It is directly forward and to the left and when full of feed, has a firm, plastic feel. It may have the shape of the end of a football. When pressed, an indentation will form which slowly fills back in and smooths over. The paunch is often mistaken for pregnancy under careless examination.

Pyometra - This condition may often be confused with early pregnancy. Pyometra is caused when there is an infection in the uterus and white blood cells form to combat the disease organism. The uterus may be fluid to the touch or be somewhat solidified, depending on the stage of the infection. Palpating for cotyledons and the uterine artery will prove or disprove pregnancy.

Large Uterus - After a cow has calved several times, her uterus may not return to normal size. The uterus may be over the pelvic ridge as in a 3 or 4 month pregnancy. Careful palpation will show an absence of uterine fluids and cotyledons.

Enlarged Cervix - At times, in Brahman or Brahman crossbred cattle, a cervix that is large and has the feel of a developing fetus may be found. Careful tracing of the reproductive tract will distinguish between the two.

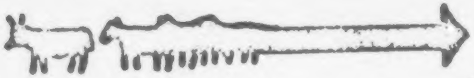
Bladder - The bladder, when full, has the feel of a 60 to 75 day pregnancy. Careful palpation will show the bladder to be a single body with no horns, as is the case with the uterus.

7. Summary of Palpation

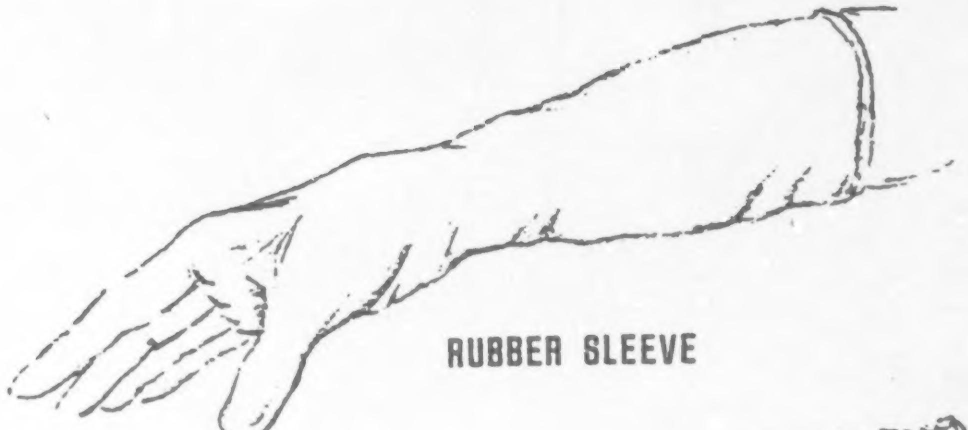
The key to accurate palpation is experience. While the cow herd is being palpated is a good time to cull cows for other reasons. Cows that are slow to conceive, calve late, and produce unthrifty calves should be culled.

Palpation accuracy can usually be increased by removing all bulls from the herd 45 days before palpating. This will allow the pregnancies to develop to a stage at which pregnancy diagnosis will be easier. Remember also to keep good breeding records as an aid to the palpator.

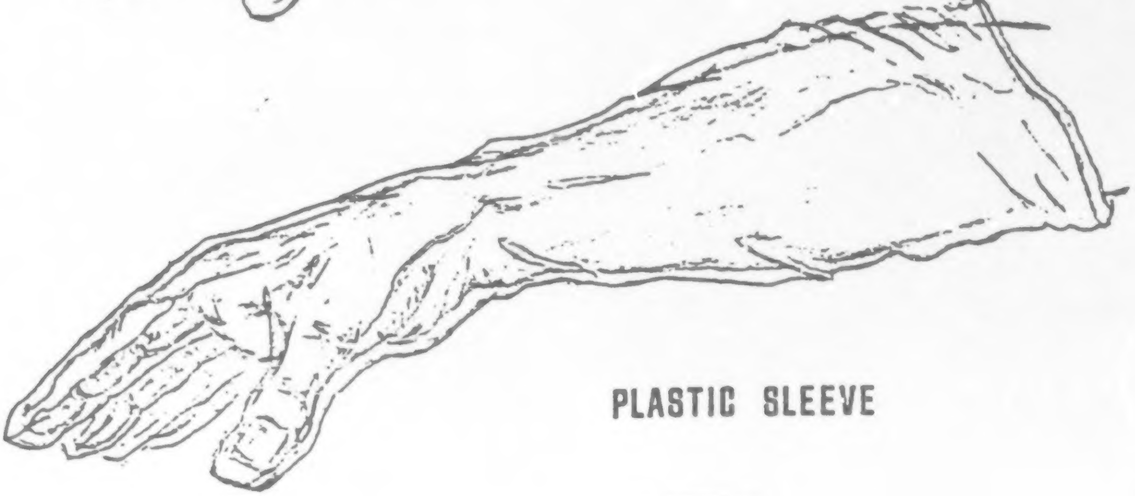
ADDITIONAL MAINTENANCE COST FROM COWS NOT CALVING

COST PER COW PER YEAR		$\$\ 80^{00}$
NUMBER OF COWS		100
TOTAL COST PER YEAR		$\$\ 8{,}000^{00}$
COWS DID NOT CALVE		25
COST PER COW		$\$\ 80^{00}$
COST THAT MUST BE PAID BY 75 COWS THAT DID CALVE		$\boxed{\$\ 2{,}000^{00}}$

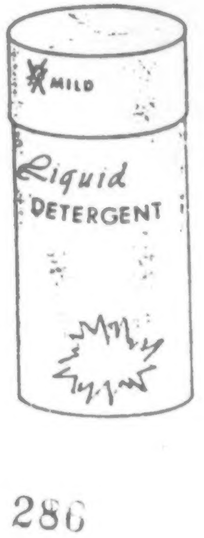
PALPATION EQUIPMENT



RUBBER SLEEVE

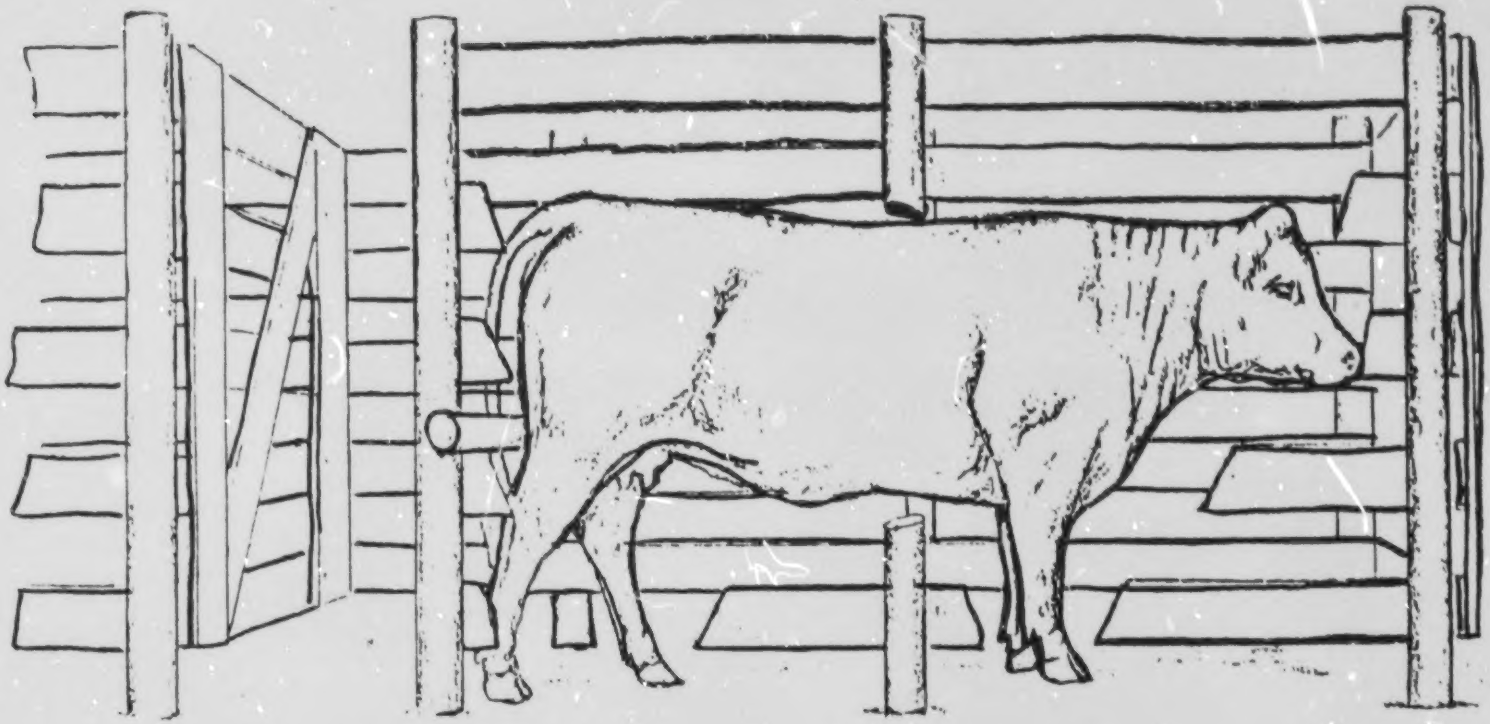


PLASTIC SLEEVE


MILD
Liquid
DETERGENT

LUBRICANT

HOLDING CHUTE for PALPATION & INSEMINATION

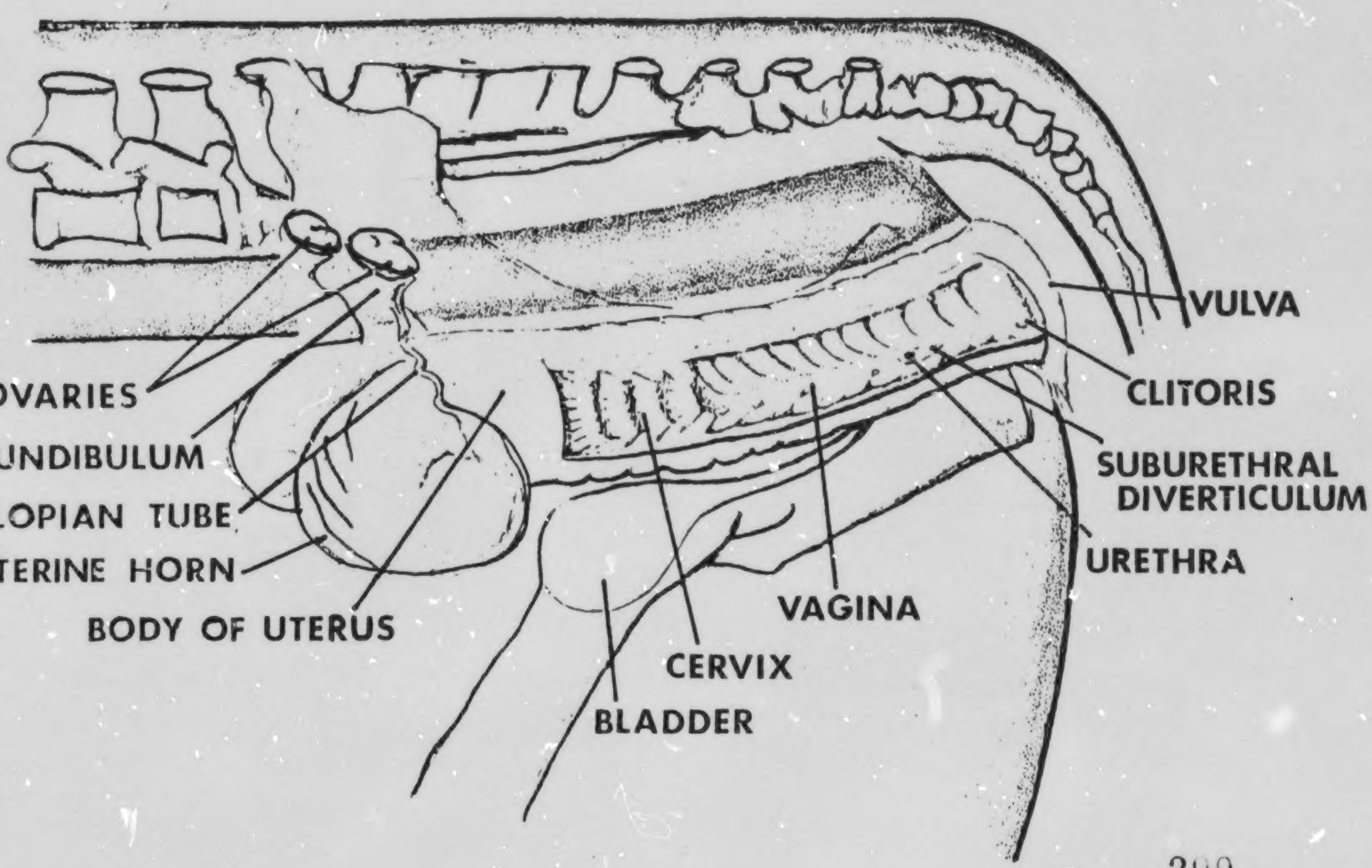


AgIII-III-109

TM-3

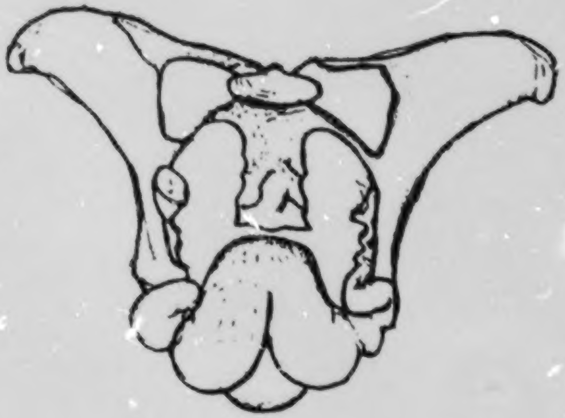
FEMALE REPRODUCTIVE TRACT

AgIII-III-110

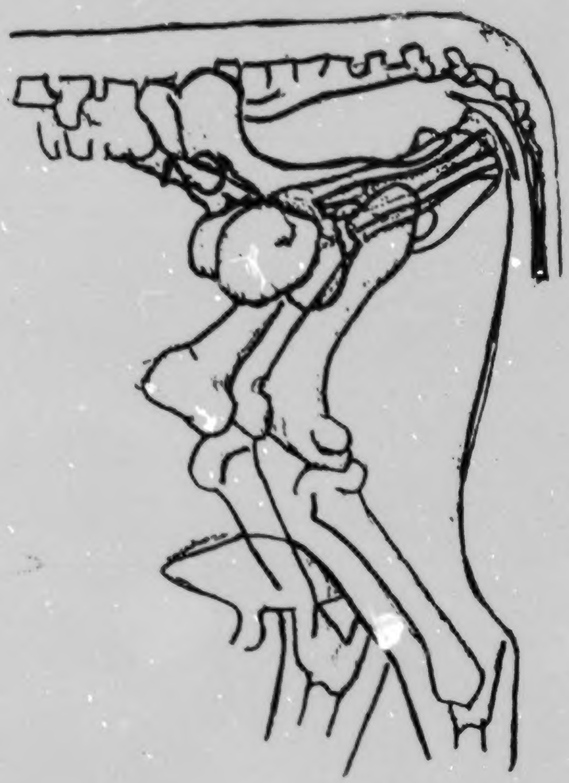

VULVA
CLITORIS
SUBURETHRAL DIVERTICULUM
URETHRA
VAGINA
CERVIX
BLADDER
OVARIES
INFUNDIBULUM
FALLOPIAN TUBE
UTERINE HORN
BODY OF UTERUS

TM-4

THE RELATIONSHIP OF THE REPRODUCTIVE TRACT TO THE PELVIS



Front view

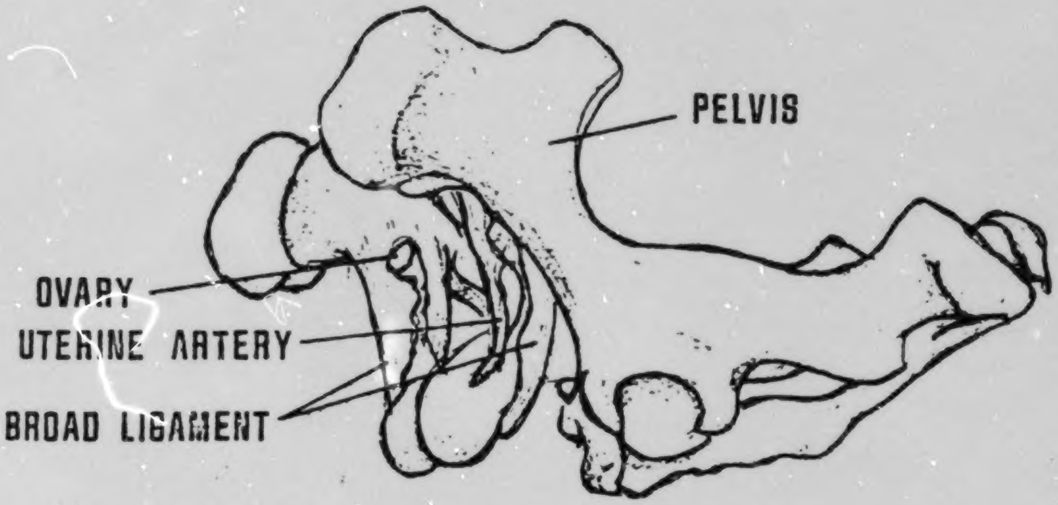


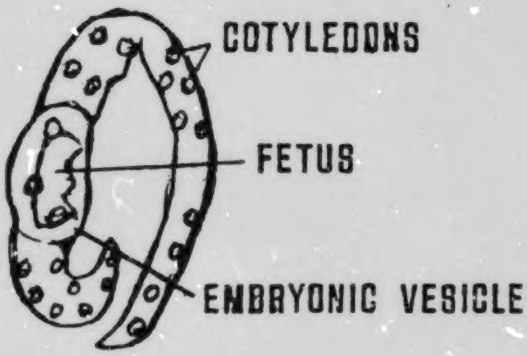
Side view

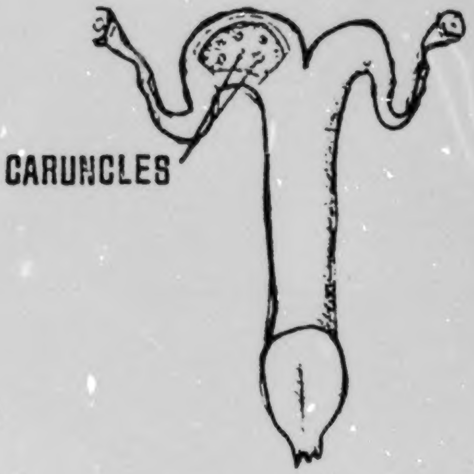
AgIII-III-111

TM-5

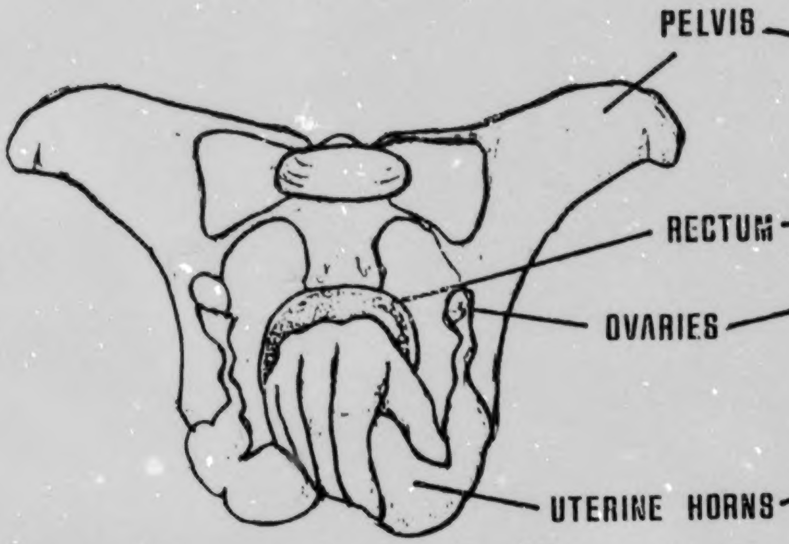
FEMALE REPRODUCTIVE TRACT

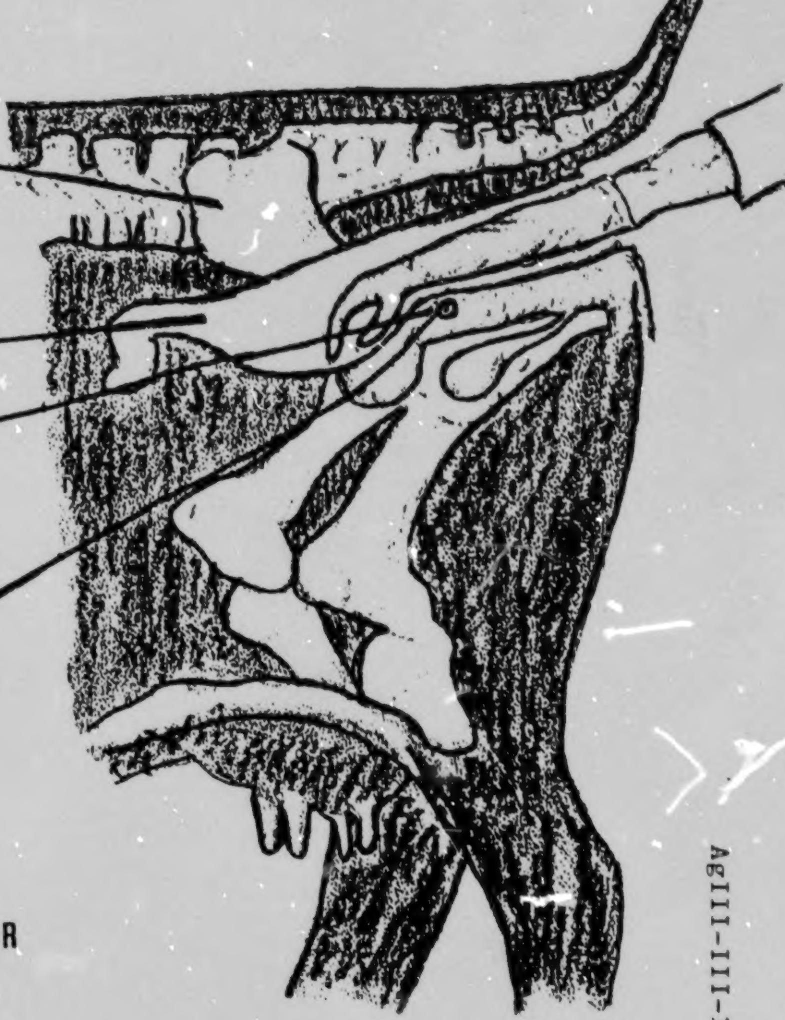

PELVIS
OVARY
UTERINE ARTERY
BROAD LIGAMENT

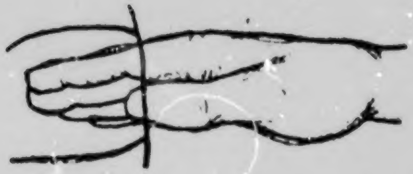

COTYLEDONS
FETUS
EMBRYONIC VESICLE



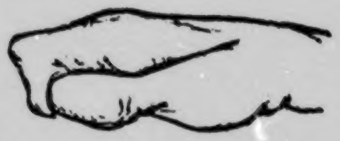
POSITION OF THE HAND IN PALPATION


PELVIS
RECTUM
OVARIES
UTERINE HORNS





INSERTING HAND INTO
RECTUM



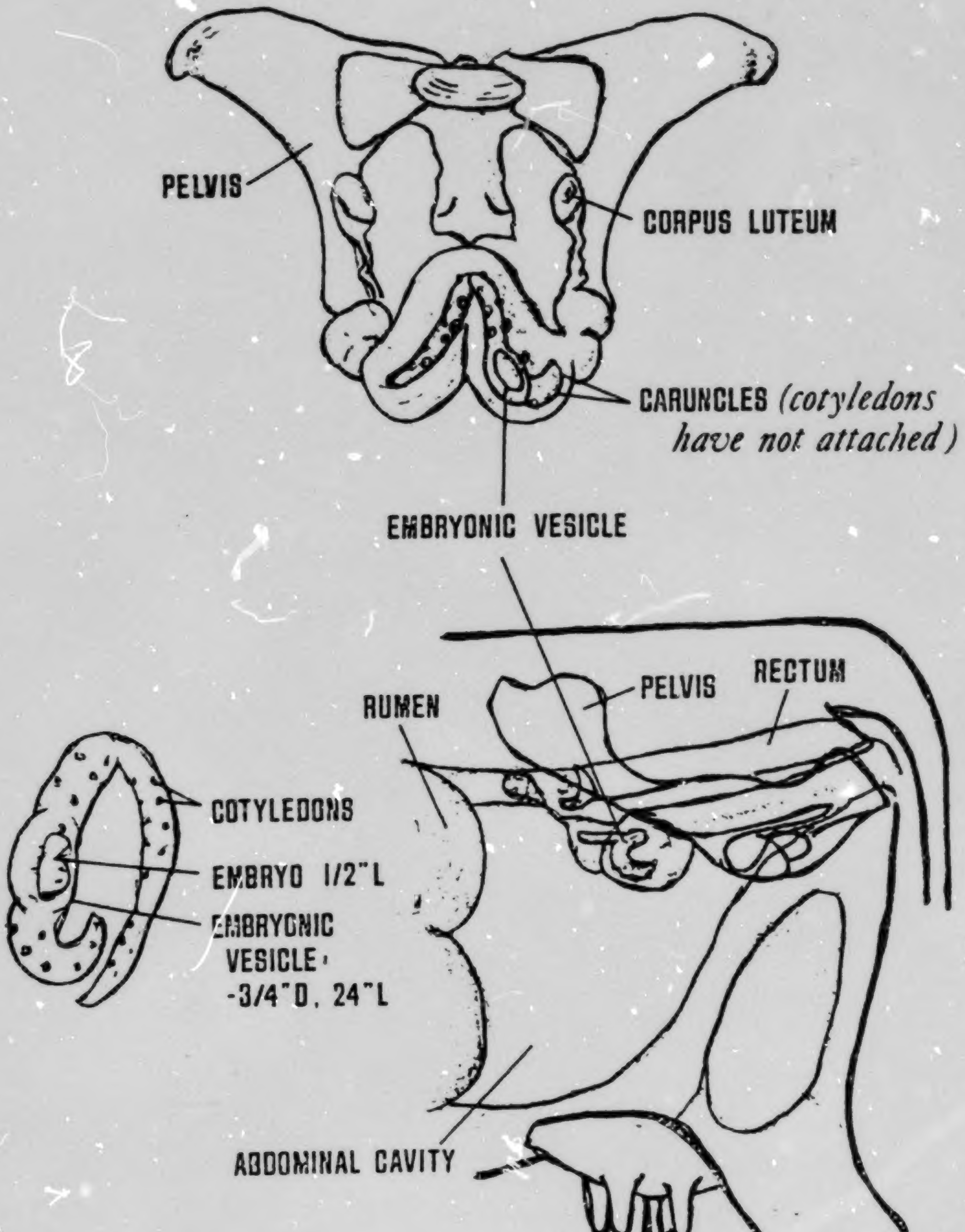
PUSHING FECAL MATTER
ASIDE

AgIII-III-113

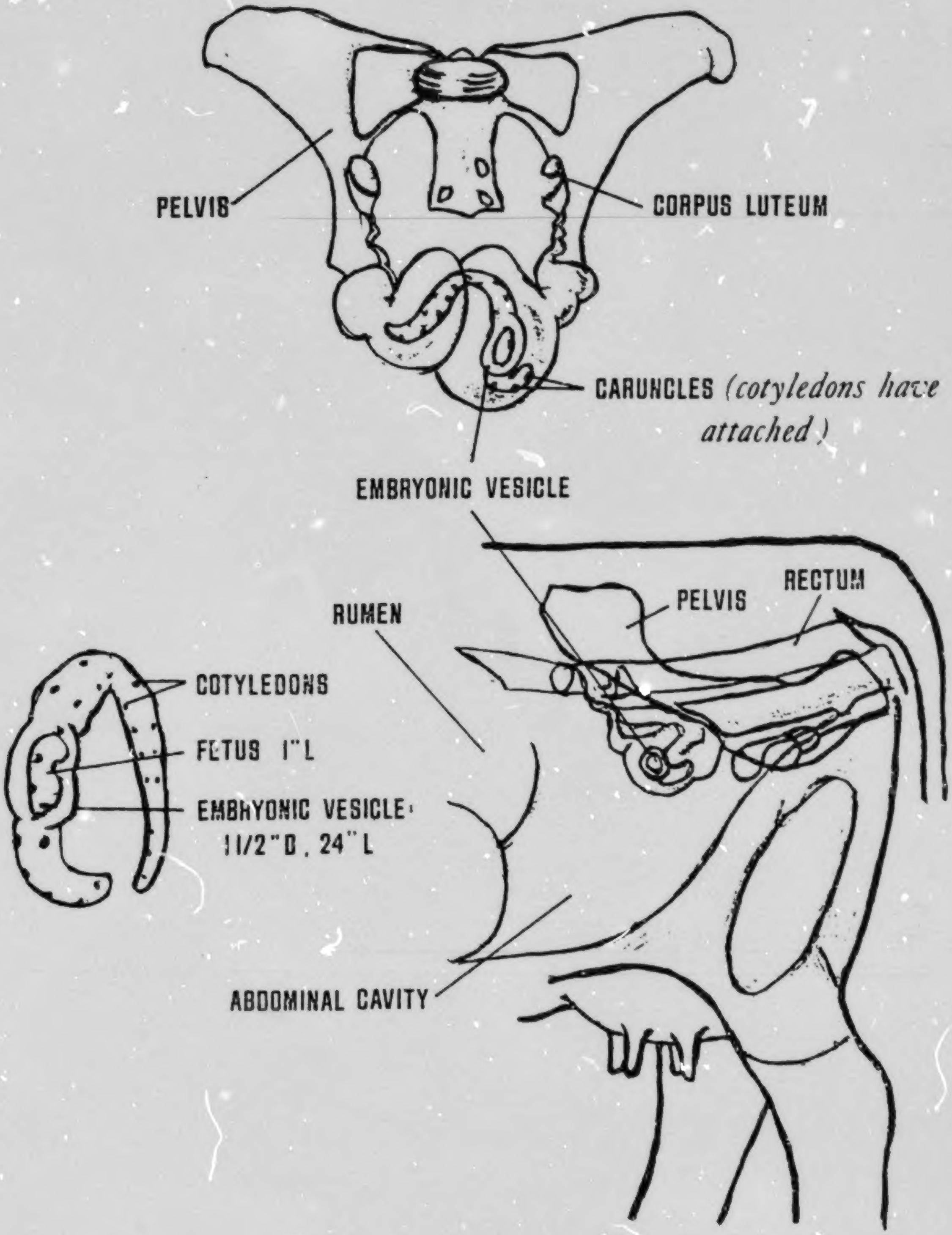
TM-7

AgIII-III-114

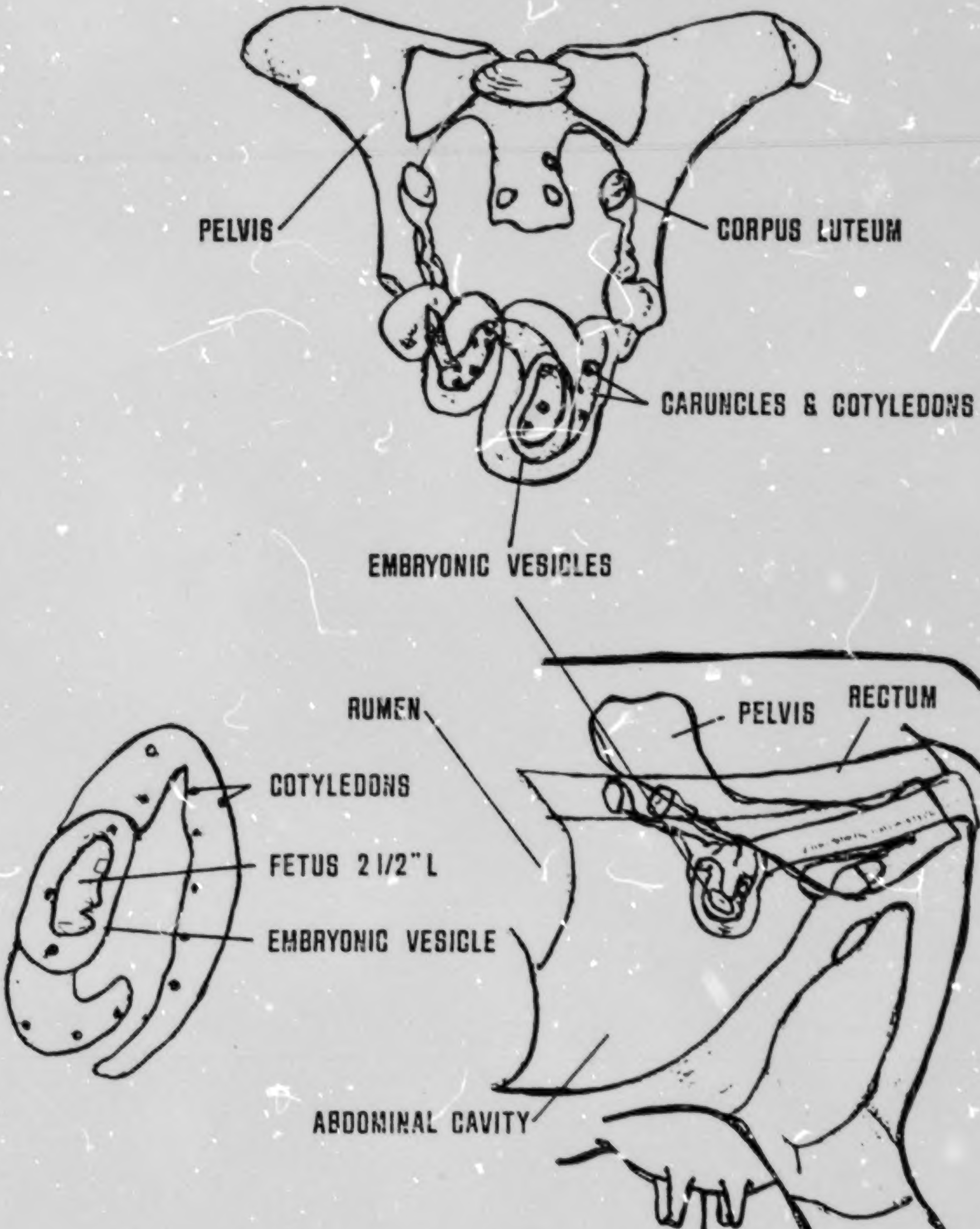
30 DAY PREGNANCY


PELVIS
CORPUS LUTEUM
CARUNCLES *(cotyledons have not attached)*
EMBRYONIC VESICLE
RUMEN
PELVIS
RECTUM
COTYLEDONS
EMBRYO 1/2"L
EMBRYONIC VESICLE, -3/4"D, 24"L
ABDOMINAL CAVITY

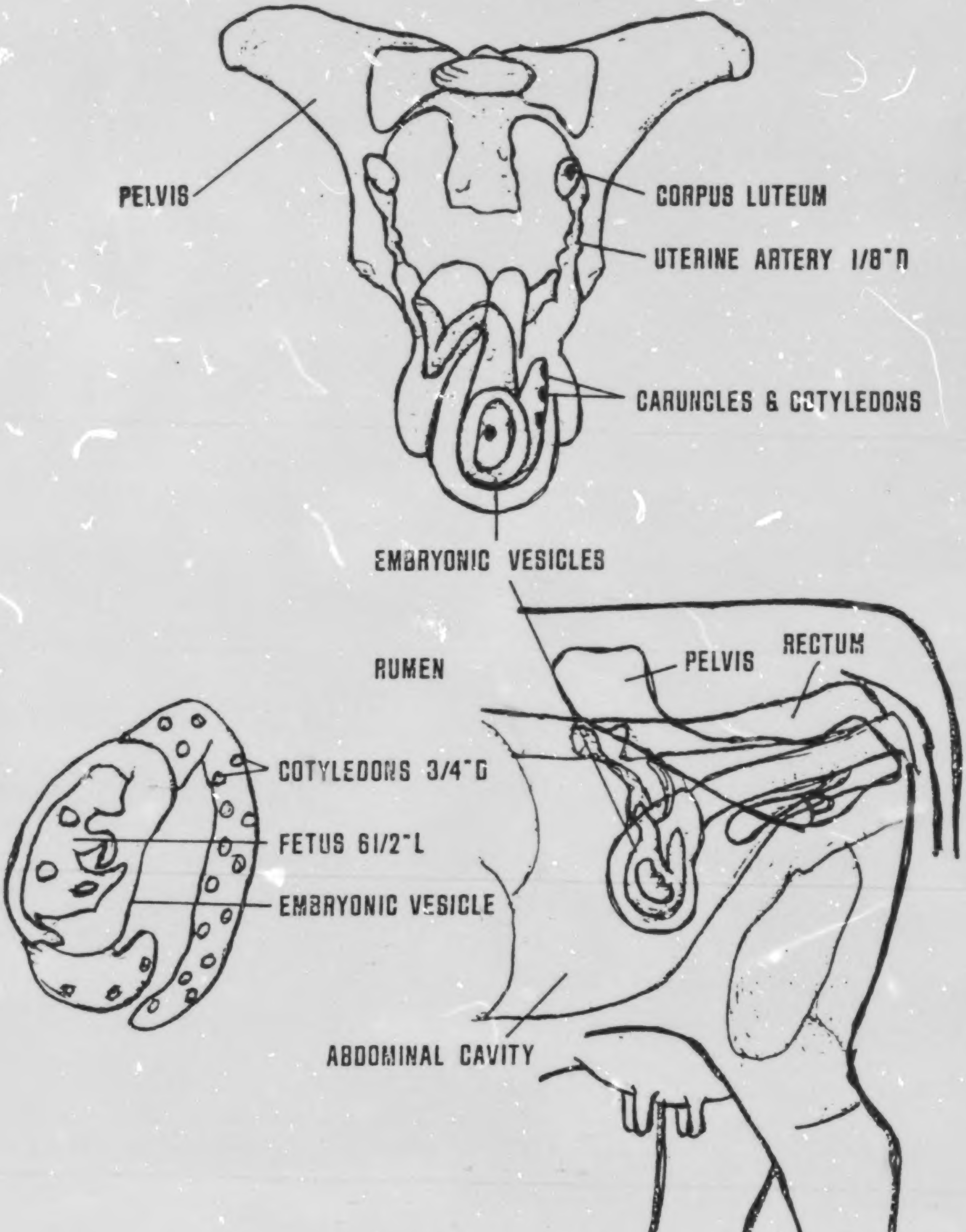
45 DAY PREGNANCY


PELVIS
CORPUS LUTEUM
CARUNCLES (cotyledons have attached)
EMBRYONIC VESICLE
RUMEN
PELVIS
RECTUM
COTYLEDONS
FETUS 1"L
EMBRYONIC VESICLE
1 1/2"D, 24"L
ABDOMINAL CAVITY

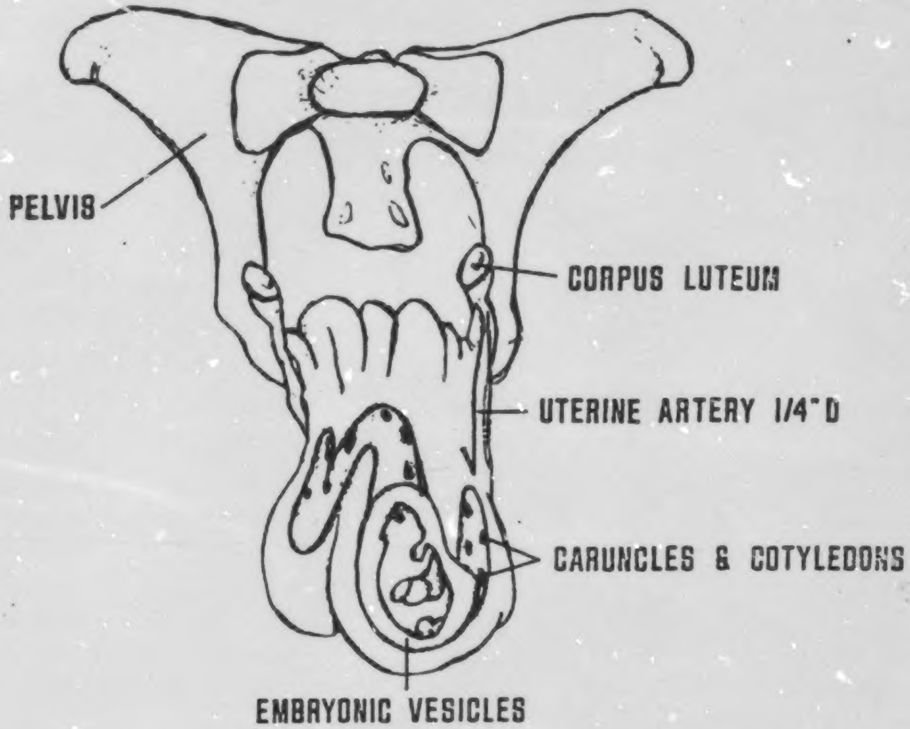
60 DAY PREGNANCY

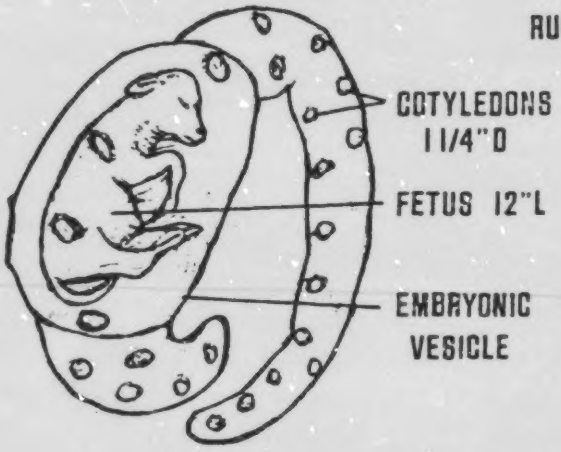

PELVIS
CORPUS LUTEUM
CARUNCLES & COTYLEDONS
EMBRYONIC VESICLES
RUMEN
PELVIS
RECTUM
COTYLEDONS
FETUS 2 1/2" L
EMBRYONIC VESICLE
ABDOMINAL CAVITY

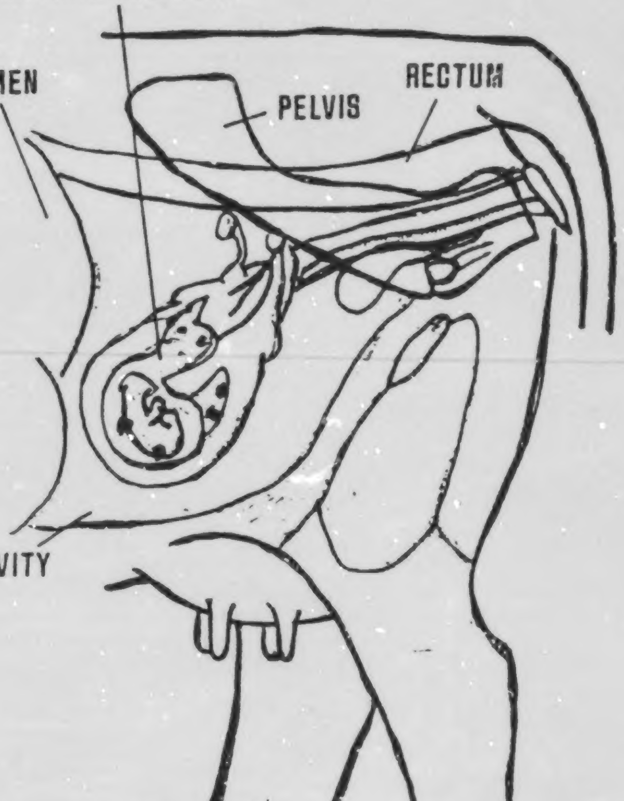
90 DAY PREGNANCY


PELVIS
CORPUS LUTEUM
UTERINE ARTERY 1/8" D
CARUNCLES & COTYLEDONS
EMBRYONIC VESICLES
RUMEN
PELVIS
RECTUM
COTYLEDONS 3/4" D
FETUS 6 1/2" L
EMBRYONIC VESICLE
ABDOMINAL CAVITY

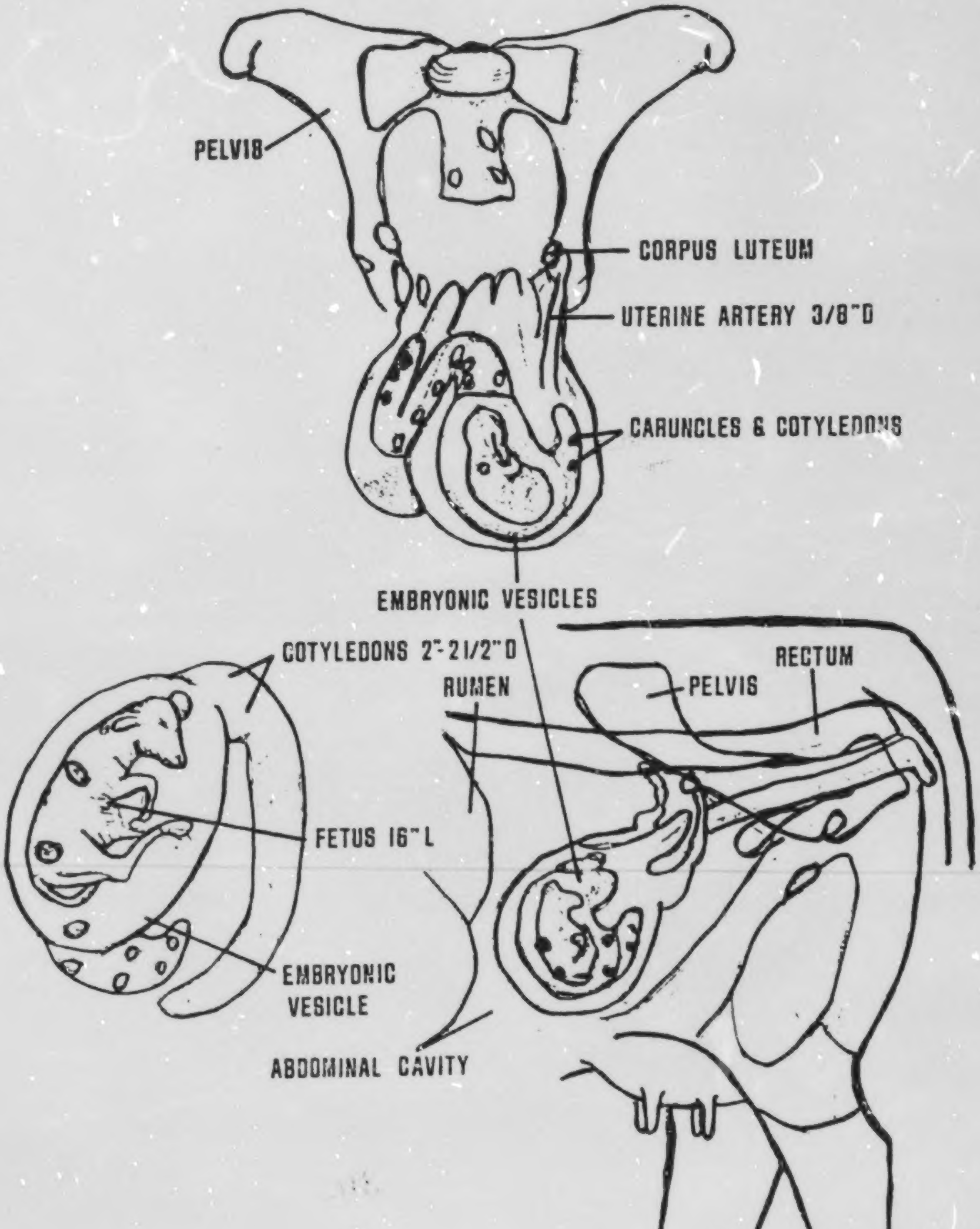
120 DAY PREGNANCY


PELVIS
CORPUS LUTEUM
UTERINE ARTERY 1/4"D
CARUNCLES & COTYLEDONS
EMBRYONIC VESICLES

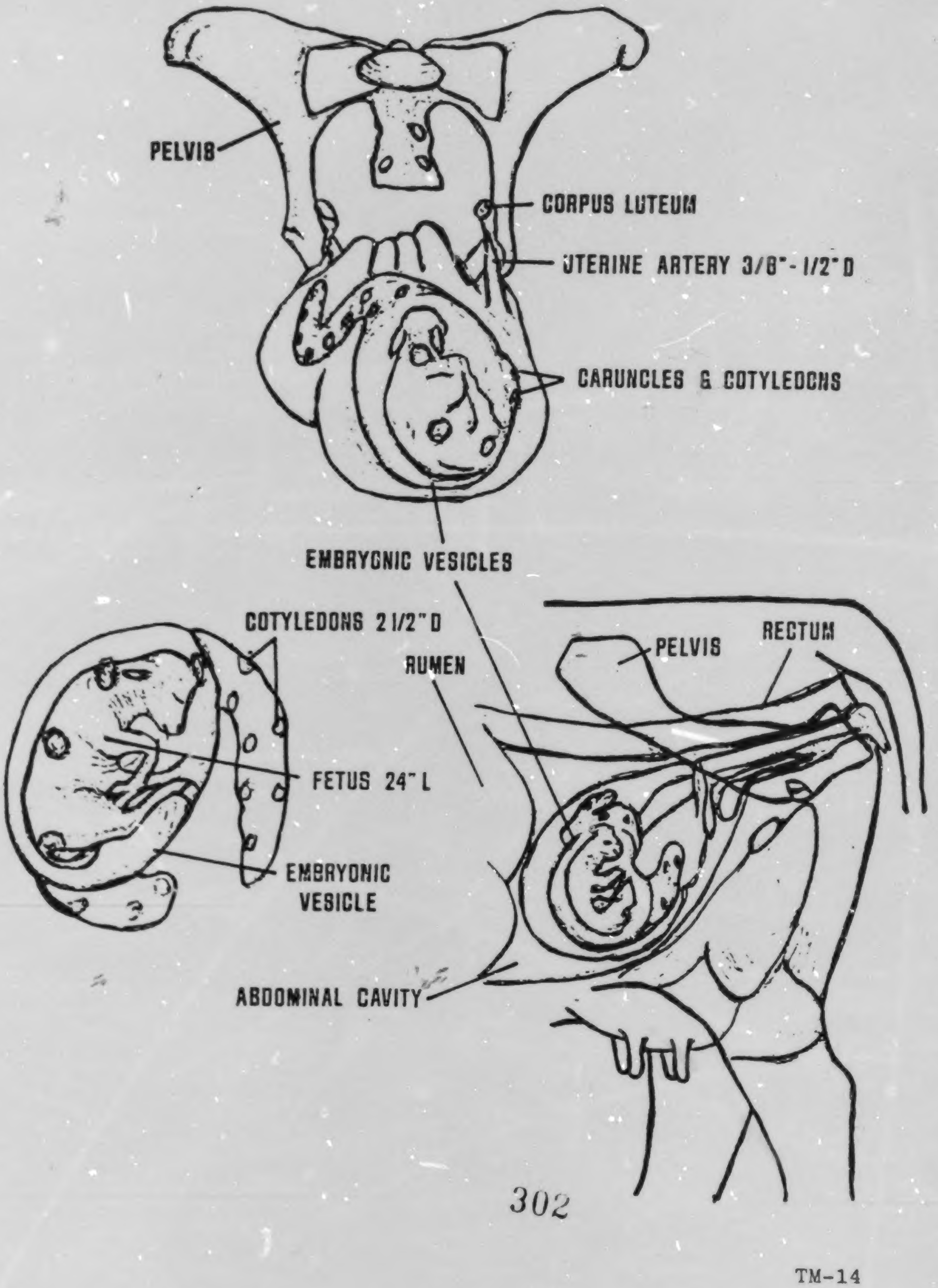

COTYLEDONS
1 1/4"D
FETUS 12"L
EMBRYONIC
VESICLE


RUMEN
PELVIS
RECTUM
ABDOMINAL CAVITY

150 DAY PREGNANCY

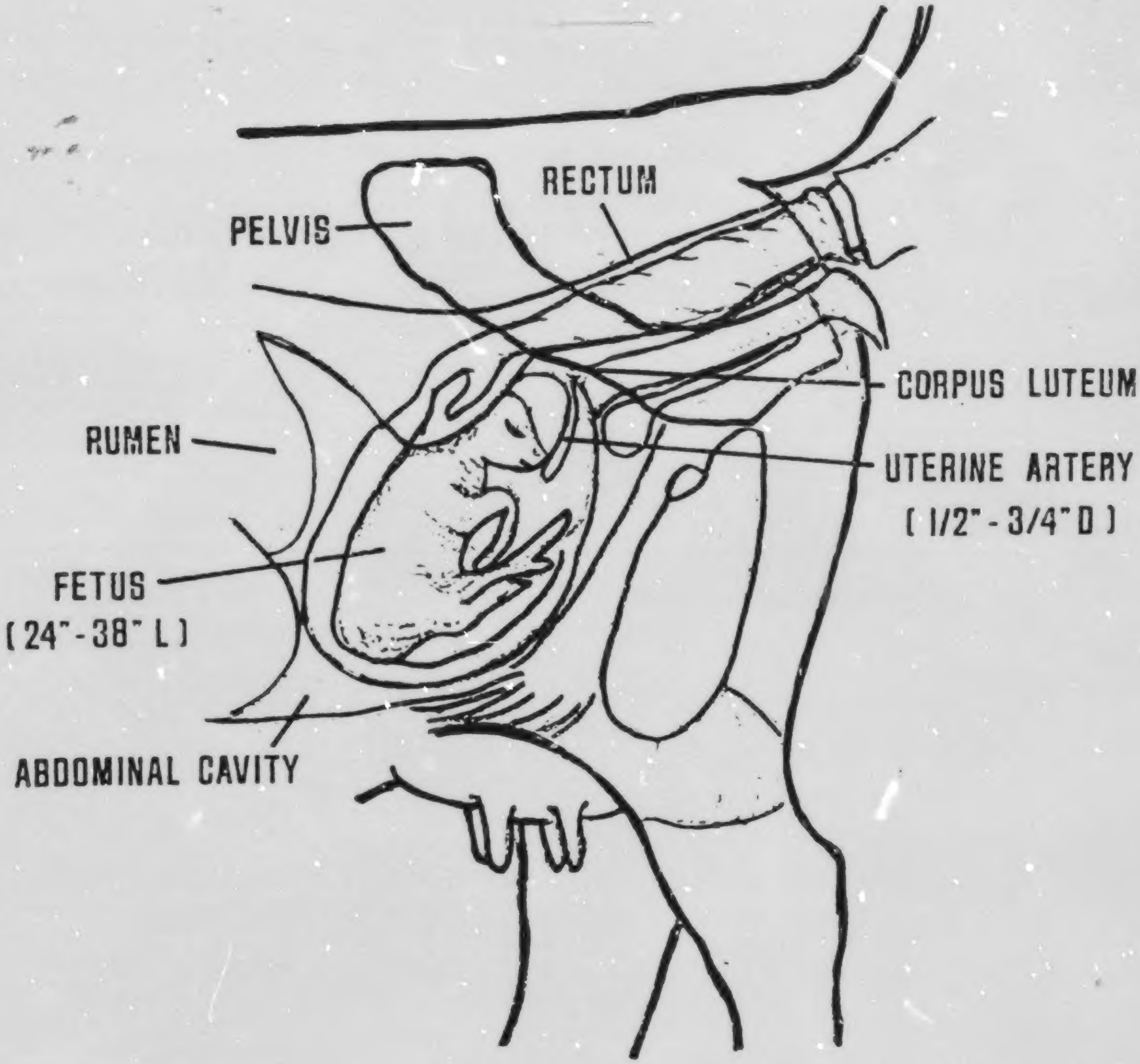

PELVIS
CORPUS LUTEUM
UTERINE ARTERY 3/8"D
CARUNCLES & COTYLEDONS
EMBRYONIC VESICLES
COTYLEDONS 2"-21/2"D
RUMEN
PELVIS
RECTUM
FETUS 16"L
EMBRYONIC VESICLE
ABDOMINAL CAVITY

180 DAY PREGNANCY


PELVIS
CORPUS LUTEUM
UTERINE ARTERY 3/8"-1/2"D
CARUNCLES & COTYLEDONS
EMBRYONIC VESICLES
COTYLEDONS 2 1/2"D
FETUS 24"L
EMBRYONIC VESICLE
RUMEN
PELVIS
RECTUM
ABDOMINAL CAVITY

210 DAYS TO PARTURITION

(FETUS MAY BE FELT)


RECTUM
PELVIS
CORPUS LUTEUM
RUMEN
UTERINE ARTERY
(1/2" - 3/4" D)
FETUS
(24" - 38" L)
ABDOMINAL CAVITY

TM-15

ANIMAL SCIENCE

Unit 1: Animal Reproduction

Lesson 8: Artificial Insemination (4½ hrs.)

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

1. History of Artificial Breeding

Artificial insemination, by definition, is the deposition of spermatozoa in the female genitalia by artificial rather than by natural means.

a. Early Development

Legend has it that artificial insemination had its origin in 1322, at which time an Arab chieftain used artificial methods to impregnate a prized mare with semen stealthily collected by night from the sheath of a beautiful stallion belonging to an enemy tribe.

The first scientific research in artificial insemination of domestic animals was conducted with dogs by L. Spallanzani, an Italian physiologist, in 1780.

A century later, American veterinarians employed artificial means to get mares in foal that persistently had failed to settle to natural service.

The Russians, with E. I. Ivanoff as the leading pioneer, were the first to use artificial breeding on a large scale. Starting about 1899, Ivanoff first experimented with horses, and he later succeeded with insemination of birds. He also was the first to succeed with cattle and sheep. In 1922, Ivanoff was called upon by the Russian government to apply his findings in an effort to reestablish the livestock industry following its depletion in World War I. Crude as his methods were, his work with horses must be considered the foundation upon which the success of more recent work is based.

The Danes acquired the technique from the Russians, and, in 1936, organized their first cooperative artificial breeding association. It is reported that the Danes, in 1951, inseminated some 914,000 cows, or approximately 55 percent of all dairy cattle in their nation.

Following World War II, British scientists made wide use of artificial insemination in re-establishing the livestock industry of England.

b. Artificial Breeding in the United States

In 1937, the North Central School of Agriculture and Experiment Station, Grand Rapids, Minnesota, conducted the first large scale demonstration of artificial insemination is still used more extensively with dairy cattle than with any other class of farm animals. In 1965, 44 percent of dairy cows and heifers (6,301,178 head) were bred by artificial insemination. In that same year, 615,147 head of beef cattle were bred by artificial insemination. The average number of cows bred per bull increased from 228 in 1939 -- when the first artificial breeding association was organized in this country -- to 3,053 in 1965. This figure represents approximately 100 times more than by natural service. Semen from some outstanding sires is now being used to breed 10,000 to 15,000 cows annually.

2. Why Breed Artificially?

Transparency No. 1

There are a number of benefits which can be realized to the fullest extent by using artificial insemination.

a. Maximum Use of Outstanding Sires

Bulls used artificially are bred to enough cows to allow much more critical selection and to prove by progeny testing, their ability to sire fast-gaining, high-quality calves. This is economically possible because A.I. bulls may be bred to 100,000 cows or more, whereas the average for natural service would be closer to 200 cows in the lifetime of a bull.

b. Greatly Increased Uniformity

The use of artificial insemination makes possible the development of large numbers of animals within a superior family, thus providing uniformity and giving a better basis for a constructive breeding program.

Under optimum conditions, it has also been established that the calving season can be shortened with a further improvement in uniformity.

c. Possible to Overcome Certain Physical Handicaps to Mating

Artificial insemination permits (1) mating animals of greatly different sizes - for example, use of heavy mature bulls on yearling heifers and (2) use of stifled or otherwise crippled sires that are unable to perform natural service. Also, it may be useful to overcome geographic or physical limitations in hybridization.

d. Lessens Sire Cost

In most herds, artificial insemination is less expensive than the ownership of a worthwhile sire together with the costs of feed, housing, and labor.

e. Alleviates Danger and Bother of Keeping a Sire

The stockman may eliminate the necessity of maintaining a sire, and he has the choice of breeding services from a wider selection of sires.

f. Reduces the Costs and Delays of Using Infertile Sires

Because the breeding efficiency of A.I. sires is constantly checked, it reduces the likelihood of breeding females to a sire that has low fertility, or one that is sterile.

g. Better Health Protection

Artificial insemination stops venereal contact. Reproductive problems in individual females are more easily detected.

h. Improved Herd Records

The sire of each offspring is known, the breeding date is known, and improved culling and management result from closer herd observation.

i. Increases Profits

The offspring of outstanding sires are usually better and more efficient producers, and thus more profitable.

j. Increases Pride of Ownership

The ownership of progeny of outstanding sires inevitably makes for pride of ownership.

3. Limitations of Artificial Insemination

Transparency No. 2

Artificial insemination, like many other techniques, is not without its limitations. Some of these are:

a. Requires Skilled Technician

Proper training and experience are essential to be successful with artificial insemination.

b. Must Conform to Physiological Principles

Much false information concerning the usefulness of artificial insemination has been encountered -- for example, the belief that females will conceive if artificially inseminated at any time during the estrus cycle.

c. May Restrict the Sire Market

As the use of artificial insemination increases, the market demand for poor or average sires will decrease. A sizeable number of the nation's beef cattle are still bred to scrub or grade bulls.

d. May Increase the Spread of Disease

Carelessness or ignorance in the use of artificial insemination could result in the rapid spread of diseases; however, no outbreaks have been reported.

e. May Be Subject to Certain Abuses

The integrity and character of the technician must be above reproach as semen is being handled and transported from farm to farm. Trained workers can detect differences in the spermatozoa of a bull, ram, boar, stallion, or cock; but even the most skilled scientist is unable to differentiate between the semen of males of the same species.

f. May Accentuate the Damage of a Poor Sire

Because of the increased number of progeny possible, when a male sires the wrong type of offspring his damage is merely increased; however, the use of tried and proven sires eliminates the possibility of using a genetically inferior sire.

g. Requires Capital and Management Ability

Considerable capital and competent managerial ability are necessary to initiate and operate an artificial breeding organization. In the past 25 years, 240 organizations have tried to develop in the business of artificial insemination of cattle, but 4 out of 5 have failed. In 1965, 42 remained; of these, 20 did 75 percent of the business.

4. The Function of the Male in Artificial Insemination

An understanding of the structure and functioning of the organs of reproduction is necessary before intelligent use can be made of the techinques of artificial insemination.

The main function of the male in reproduction is the production of male sex cells, or sperm cells (spermatozoa), which are needed to fertilize the eggs of the female. In natural mating, the male deposits these spermatozoa in the female reproductive tract.

Transparency No. 3

The reproductive organs of the bull consist of the testicles and epididymides (carried in the scrotum), vas deferens, ampullae, urethra, accessory glands, and penis. The testicles produce the sperm cells and the male sex hormone, testosterone. The male hormone causes the development of male characteristics such as the heavy neck and shoulders and the deep voice of a bull.

The formation of sperm cells takes place in very small tubes in the testicles. Normally the testicles are found suspended in the scrotum. By raising or lowering the testes, the scrotum provides a relatively constant temperature (lower than that of the body) which is essential for sperm production. Sperm produced in the testis pass into the coiled tube, or epididymis, that lies along the back side of the testicle. The epididymis services as a storehouse where millions of sperm mature, or ripen, so they are capable of fertilizing an egg. At the time of mating, or ejaculation, sperm are carried from the epididymis through the long, slender tube--the vas deferens--which connects the epididymis from each testicle with an ampulla. The ampullae are thickened areas of the vas deferens found high in the body cavity near the point where the two join the urethra. From the ampullae, sperm pass into the urethra, the common passageway for both semen and urine.

Near the point where the urethra and ampullae join are found the accessory glands called the seminal vesicles and the prostate. A short distance to the rear along the urethra is another pair of accessory glands, the Cowper's glands. Fluids from all of these accessory glands are added to the sperm from the testicles at the time of ejaculation. These fluids help transport the sperm, supply the proper environment to help keep the sperm alive, and even cleanse the urethra prior to the time that the sperm pass.

The urethra continues from high in the body (just below the rectum) through the penis to the exterior. Semen follows this path at the time of ejaculation. The penis of the bull, ram, and boar is constructed with an S-shaped curve in it. At the time of erection and mating, this S-shaped curve straightens out, thus enabling the penis to be extended to deposit semen in the vagina of the female.

5. Semen Collection, Processing, and Storing

Semen is an opaque, whitish fluid discharged by the male at the time of mating. There are considerable differences in individuals and species of semen volume and sperm numbers. They are influenced by age, season of the year, general health, and sexual use. The ram is capable of repeated service without noticeable decline in volume and sperm concentration. In boars and stallions, service rates higher than twice daily usually affect semen quality.

Transparency No. 4

Semen characteristics may be expected to be equal to the species averages shown in this table.

The semen consists of a fluid part and a cellular part. The cells are the male reproductive cells or sperm cells and are produced by the testis. The fluid portion of the semen consists of secretions from the various glands in the reproductive tract of the male.

Transparency No. 5a

The sperm cells are microscopic in size and when observed under the microscope, they appear much like miniature tadpoles as they swim by their tails. Normal sperm consist of a head, a neck, a body, and a tail portion. The head in profile is flattened but, as seen under the microscope, is rounded or oval. It consists chiefly of nuclear material and is covered by a thin layer of cytoplasm. The head is of great importance because is contains the chromosomes (genetic materials).

The neck is very short and contains the anterior centrosome. The body is about the same length as the head. The movement of the sperm is brought about by the lashing of the tail.

Transparency No. 5b

Although there are minor differences in size, all spermatozoa are extremely small. A cow egg or ova has a diameter approximately 20 times greater than the length and 40 times greater than the width of the head of a bull sperm cell.

Transparency No. 6a

This illustration was taken from microphotographs of the sperm of a bull with a good breeding record. Cows bred to this bull required about 1.25 services per conception. Notice the uniformity and fullness of the heads. The tails appear normal, permitting vigorous motility of the sperm after it has been introduced into the female genitalia.

Transparency No. 6b

The second illustration shows sperm of a bull with a poor breeding record. The heads appear normal in size and shape, but it contains many sperm with coiled tails, and a few were tailless. Only a slight rate of movement was noted and some may have appeared to have been lifeless. This bull required over 3 services per conception when used on good breeding cows.

Transparency No. 6c

The third illustration shows semen from a bull with a questionable breeding record. The sample contained semen with about 25 percent abnormal sperm. It had good mobility and fair viability. The service ratio was about 2.5 services per conception.

a. Semen Collection

The method of collecting semen should be reasonably adapted to the males of the species, should be easy for the operator to use, and should permit the collection of a sample of normally ejaculated semen free from contamination with dirt, bacteria, or excess secretions from either the male or the female genitalia.

1) The artificial vagina

Many techniques have been developed for the collection of semen, but the most satisfactory one consists of using the artificial vagina, a Russian invention. Males usually respond to this method with little previous training. It is the most satisfactory method of collecting semen from the bull, stallion, or boar and may be used for the ram.

Transparency No. 7

An arfiticial vagina is made of two tubes--an outer one of heavy rubber and an   lining of thin rubber. The space between the two tubes is filled with warm water. One end of the vagina is left open to permit the penis to enter. The other end leads to a graduated test tube into which the semen flows after ejaculation.

Best results are usually attained when the male is allowed to mount another animal and the penis is quickly diverted into the open end of the artificial vagina. If the vagina has been properly prepared, ejaculation is very shortly initiated.

Preparation of a bull for collection is important. A "teasing" period before collection, during which the bull may be permitted to mount the teaser animal but not ejaculate, or may be restrained from mounting although he desires to do so, results in an improvement in the quantity and quality of semen produced. At collection, as the bull mounts a cow, a steer, or a dummy, his sheath is grasped and the penis quickly guided into the artificial vagina. If the proper technique, temperature (110° to 130°F), pressure, and lubrication have been observed, the bull will ejaculate immediately. The average semen volume per ejaculate is 8-10 cc., containing on the average 8 to 15 billion sperm.

The graduated test tube in which the semen has been collected from the artificial vagina is taken to the processing laboratory as soon as the collection is finished. The test tube itself indicates the volume of semen collected.

(2) Electrical stimulation

Collecting semen by electrical stimulation has been used on rams for several years. Only since 1950, however, has the method been put to use with bulls. The use of the electro-ejaculator has overcome many of the difficulties experienced in using other methods for testing range bulls. If a bull is restrained properly in a good chute, semen can be collected with this machine regardless of the bull's disposition.

Transparency No. 8

The electro-ejaculator was developed to produce an electrical impulse to stimulate the nervous system supplying the reproductive tract, causing erection and ejaculation.

Electrodes are inserted into the rectum of the bull after the feces have been flushed out with a salt solution. Low-power stimulations given intermittently should be increased gradually to obtain extension and erection prior to ejaculation. The first fluid that passes is a clear, watery secretion from the accessory glands which contains few, if any, sperm cells. Following this, the ejaculate turns into a milky fluid consisting of sperm and accessory fluids. A collection is made at this time for evaluation. The collection is made in a test tube attached to a flexible plastic funnel which reduces breakage and injury. The reproductive organs should be examined for abnormalities at the time of testing.

3) Massage of the ampullae

This method requires a well-trained operator who inserts the hand into the rectum and massages the ampullae and accessory glands, causing semen to drip from the sheath. Semen collected by this method is of poor quality, because it may be contaminated with urine and may contain too much accessory gland secretion for the number of sperm present. This system has been used successfully with bulls and stallions.

4) Recovery of semen from the vagina

Natural service is first allowed. Then the semen in the anterior vagina is aspirated into a syringe by means of a glass or rubber catheter that is introduced into the vagina. Semen collected in this way is usually contaminated with the secretions of the female, and there is greater danger of spreading disease. Some operators prefer this method with sheep. It cannot be used with swine.

b. Semen Processing

1) Testing of Semen

The thickness, or density, of the semen is tested in a photelometer which estimates the number of sperm by means of a photoelectric cell.

Next, the semen is examined under a microscope. A drop of fresh semen is placed on a glass slide. The observer notes what percentage of the sperm in the sample move. If 80 percent or more of the sperm move, the "percent motility" is excellent; 70 percent is good; 50 percent to 60 percent fair. Rapid forward movement is desirable.

Another characteristic to check for is the morphology or the appearance of abnormal sperm.

Semen samples may be examined with the naked eye to determine its quality, but with much less quality.

2) Extending semen

Millions of sperm are ejaculated by the male at the time of mating. In natural mating, all these sperm are used to breed one female, even though only one sperm of the millions fertilizes the egg. An ejaculation of the male can now be extended or diluted so that many more females can be bred with it. This is accomplished by adding materials to the semen which help to keep the sperm alive and at the same time give the sample more volume.

Transparency No. 9

The table shown in this transparency lists the four most commonly used semen diluters and gives the classes of animal for which it is satisfactory.

1. Egg yolk - citrate
2. Egg yolk - phospate
3. Homogenized whole milk
4. Glycine-containing diluents

Antibacterial agents are added to the extenders to help control bacterial growth. Antibacterial agents commonly used are:

Sulfanilamide - 3 milligrams per cc final diluent
Penicillin - 500 units per cc final diluent
Streptomycin - 500 micrograms per cc final diluent

In order to keep sperm alive, it is important that the diluents be added a few minutes after the semen is collected from the male. It is also important that sperm never be cooled suddenly. They can withstand slow cooling, but cold shock is extremely harmful. Thus, the semen and the diluent should always be near the same temperature.

Semen that is undiluted will not live much over 24 hours at room temperature. By adding diluents and slowly cooling the semen to refrigerator temperature, 41°F, the sperm may frequently be kept fertile for nearly a week, and active movement can be maintained for 20 to 30 days. The reduced temperature slows the sperm until it is inactive; thus its energy is saved.

c. Storing Semen

1) Preparations for storage

After special treatment of semen with the selected extender, the sperm can withstand freezing to extremely low temperatures. Usually the semen is collected and diluted in the manner already discussed. After it is cooled, a 7 to 10 percent glycerol solution is added slowly over a one-half hour period. The sperm are then allowed to stand in the refrigerator for 6 to 18 hours.

2) Ampuling

Transparency No. 10

The basic unit for semen storage and shipment is an individual glass ampule, containing just enough semen for a single insemination. After the semen has been collected and evaluated, glass ampules are prepared to receive the semen.

Each individual ampule is identified with the sire's name and registration number, breed, a code number, and identification as to the specific collection. The filling and sealing operations are done in refrigerated rooms maintained at 40°F. Careful attention is given to the volume of semen in each ampule and to the quality of seal.

Table 1: Volume of Semen and Concentration per Insemination

Species	Semen Dilution Ratio	Volume of Semen Needed per Service	No. Sperm Per Insemination
Bull	1:200	*1 cc	15 million
Stallion	--	5-10 cc	250 million
Boar	1:8	50-100 cc	2 billion
Ram	1:1	*1 cc	50 million

*1 cc is the volume of semen contained in each ampule of bull and ram semen.

After filling and sealing, each ampule is clipped, one above another, to a metal holding device called a hack. This provision for vertical storage makes it possible to store many ampules of semen in a very compact space.

3) Freezing and storage

Finally, by using liquid nitrogen or dry ice in an alcohol bath, the diluted semen with the glycerol added is slowly frozen. When maintained at -110°F (dry ice) or -320°F (liquid nitrogen) until needed for breeding, semen will stay fertile and can be stored for months or perhaps years. It is important that the low storage temperature be maintained constantly; otherwise, the sperm will die.

The technician has the responsibility of handling the frozen semen in order to preserve its quality. Most technicians store the ampules of frozen semen in a liquid nitrogen container (refrigerator) such as the one illustrated. This particular liquid nitrogen container holds up to 480 ampules and may be safely stored for as long as 60 days.

6. The Function of the Female in Artificial Insemination

Transparency No. 11

The female mammal produces sex cells or eggs and furnishes a place within her body where these eggs, if fertilized, can grow and develop into young. The important parts of the female reproductive tract are the ovaries, oviducts or fallopian tubes, uterus, cervix, vagina, and vulva. (The function of these parts was discussed in the unit on "Palpation.")

The eggs produced by the ovaries of mammals are tiny structures which are very fragile. It has been estimated that an ordinary thimble, which would hold about 3 cc of fluid, would hold 2,000,000 cow eggs. Usually in the cow and mare, only one egg is released during each heat cycle. In the ewe, one or two and sometimes more are released. Many eggs are released in the sow at each heat and if they are fertilized by the male sperm, this results in litters being produced instead of only one or two young.

In addition to the egg-producing role, the ovaries play an important part in female reproduction by producing certain hormones which cause the female to be receptive to the male. This receptive period is called the heat or estrus period. Not only will the female accept the male at this time, but also this period usually marks the time when eggs are released from the ovaries.

7. Heat Detection and the Importance of Timing in Artificial Insemination

a. How to Find Cows in Heat

Successful, practical artificial insemination requires that a man's judgment be substituted for a bull's instinct. Should the man be less dilligent or conscientious in the task of detecting cows in heat than a bull, the time when some cows are in heat will surely be missed, and they will pass out of heat un-inseminated.

Cows in heat are under the influence of a sudden, high-level occurrence of female sex or "heat" hormone (estrogen). The egg-containing follicle which produces the hormone, is at the height of its growth.

The nervous system is greatly affected. The cow is excitable and may do an unusual amount of bawling. She is restless and often walks the fences. The herdsman who knows his cows well can often recognize heat by the alert, bright-eyed, nervous appearance shown by cows during this period.

Cows in heat attempt to ride other cows. They stand to be mounted by other cows. Under conditions of natural service, they would stand and accept service by a bull. Standing is the only reliable, practical test for heat. When a cow stands she is in heat and is ready for service.

Ruffled hair over the tail head suggests that a cow has recently been ridden; she may or may not have been in heat. When cows "sniff around" one another, such is a common sign that one is approaching or is in early heat. Riding follows. Then--the cow in heat stands.

Many heifers and cows in heat flatten themselves down in the loin region. This presents a "sway back" and "high tail bend" appearance.

The heat hormone from the ovary also has an effect upon the genital organs. Genital mucous becomes greater in quantity and thinner in quality. It may even flow from the vulva in long strings. Wet mucous smears are often noticeable on the buttocks, over the pin bones, and under the tail.

The vulva of a cow in heat appears somewhat swollen. The skin becomes more moist and less wrinkled. The fine hairs stick together because they are wet. The vulva of the cow when not in heat appears sunken. The skin is dry and in tiny folds and wrinkles.

The second and third day after heat, but sometimes earlier, bloody mucous passes from the cow's vulva. This may be notices smeared on the buttocks or tail or, after lying down, in a pool behind the cow. Bleeding from the cow means that she has been in heat (ovulation implied) 2 or 3 days before. Whether a cow bleeds or does not bleed after heat has nothing to do with whether she has conceived or has not conceived from service or insemination at that heat.

Similar conditions to some of those described for finding cows in heat may be observed in other classes of farm animals.

b. Heat Detection Procedures

The herd management conditions determine the exact procedures to be followed in observing the individuals of a herd for signs of heat. This should be done at least twice each day. Animals in pasture must be carefully observed. A record-keeping system which tells when particular animals require watching helps in detecting females in heat. Adequate pens and holding facilities are very important in an A.I. program.

c. The Importance of Timing in Artificial Insemination

It must be understood that the female is fertile only when an egg is present which can be fertilized. Likewise, it must be understood that an egg can live only a short time after being released from the ovary unless it is fertilized.

Transparency No. 12

The optimal time for insemination is in advance of the time of ovulation, which varies according to species.

Mares normally ovulate 24 to 48 hours before the termination of the heat period, cows about 10 to 12 hours after the end of heat, ewes near the end of heat, and sows about 30 to 40 hours after the beginning of the heat period. Thus a mare with a 5-day heat period should be inseminated on the third day and at least every other day thereafter for the duration of heat. Cows should be inseminated during the latter half of the heat period, ewes during the last day of heat, and sows 12 to 24 hours after the beginning of heat. In sows, a second service 12 to 24 hours later increases conception and litter size.

Transparency No. 13

The following graph shows the percent of conception on first service and the best time to breed cows.

For highest conception rates in cattle, breed 60 to 90 days after last calving.

Best results will be obtained if cows are bred during the period of from 6 hours following beginning of true heat to 2 hours after the end of true heat.

Sperm will live about 24 hours in the female reproductive tract.

Sperm should be present in the female reproductive tract well before the egg is released.

True heat is demonstrated when the cow will stand to let other cows ride her.

Fertilization occurs immediately if sperm is present when the egg is released. If not, the egg may be fertilized during the next 6 to 10 hours.

8. The Insemination of the Female

Cleanliness during all insemination manipulations is essential and is the crucial point for success or failure. This applies to the instruments used, to the hands of the operator, and to the animals.

a. Prepare the Semen

1) Care should be taken in handling the semen ampules since exposure of frozen semen samples to air for over 20 seconds may lower the fertility of the semen.

2) Always wear gloves in handling frozen semen. The hazard of frostbite is not great, but it can happen. Some ampules, because of a faulty seal, explode rather violently and throw shattered glass in all directions.

3) Thaw water should be between 32^{o} and 40^{o}F (iced water), and the semen ampule should be put into the thaw water with not more than ten seconds exposure to air.

Frozen semen can be warmed rapidly without harm as long as the temperature does not rise above that of the body. There is less danger of cold shock when thawed in iced water, but thawing and holding ampules in ice water for several hours is not recommended.

b. Inseminating Technique

The procedures used in artificially inseminating female farm animals vary with the species involved. The cow and ewe have cervixes which are rather tightly closed. With these two, the cervix must be seen or grasped with the hand in order to insert the inseminating tube. In the mare and sow, the cervix is more open and will admit an inseminating tube more easily. In the smaller animals it is difficult or impossible to insert a gloved hand into the rectum to guide an inseminating tube. Thus the sow with an open cervix can be inseminated simply by directing the tube into the vagina and carefully working it forward into the cervix. In the ewe, a speculum can be used to hold the walls of the vagina out so the opening of the cervix can be seen with a flashlight. The speculum method can be used on larger animals also.

1) Artificial insemination in cattle

Transparency No. 14

The rectovaginal technique can be used with cows and mares. In this method, one hand covered with a rubber glove or disposable plastic glove-sleeve is inserted into the rectum. Most inseminators prefer to use the left hand for manipulation of the cervix through the rectal wall and the right hand for directing and controlling the inseminating tube.

The human hand working within the rectum must respect the physical makeup of the tissues and organs that are contacted. The technician must realize that serious damage will be done to the rectal wall, ovaries, or uterus when these structures are improperly handled.

Lubrication of the hand and arm is very helpful. Water is usually sufficient. A simple mild lubricant such as a K.Y. Jelly or equivalent, obtainable at most drug stores, may occasionally be necessary. Soaps or detergents are not recommended as lubricants since they are sometimes irritating and may be harmful to the sperm.

The technician's hand should be entered into the rectum by holding the fingers in a coned position and inserting the hand through the anal opening. The entire hand and as much of the arm as is needed can be passed into the rectal cavity. The cervix is located and then held and manipulated through the floor of the rectum. The other hand introduces the inseminating tube (pipette) 5 to 6 mm in diameter and 40 cm long, containing 1 ml (cc) of diluted semen, through the vagina. The hand within the rectum manipulates the cervix to permit the passing of the tube into the cervix.

In the cow, the semen is deposited in the cervix. The tube tip should not enter into the body of the uterus or the horns of the uterus, as it could damage the very fragile lining of that organ.

After passing the inseminating tube through the vagina and just through the cervix, depress the bulb slowly so that the semen does not adhere to the wall of the inseminating tube. Then withdraw the arm and hand slowly from the cow.

Results obtained by using the method on cattle have frequently been better than those obtained by natural mating. In natural service, the bull normally deposits the semen in the vagina next to the cervix, and the sperm apparently pass through the closed cervix with little difficulty. Presumable, contractions of the uterus, caused by the hormone oxytocin, are responsible for the quick transportation. It is believed that the sperm must be in the female reproductive tract for 4 to 6 hours to develop the capacity to fertilize an egg. Since sperm live only about 24 hours in the female reproductive tract, the best time for insemination is between mid-heat and 6 hours after the end of heat. Breeding at this time enables the sperm to have the ability to fertilize the egg and remain in waiting in the oviduct for the egg to be released from the ovary.

Another important consideration in breeding cows is the time of rebreeding after calving. Too often the cow is given too little time to recover from the strain of carrying and delivering the previous calf. Careful studies have shown that at least 60 days should be allowed after calving before rebreeding. This is necessary to allow the reproductive tract of the cow to return to normal. When at least 60 days rest are allowed, the chances of getting the cow to conceive are better. Also, there is less chance of causing future breeding troubles.

2) Artificial Insemination in Horses

There has been less interest in, and more resistance to, artificial insemination in horses than any other class of livestock.

Artificial insemination is not permitted by some horse breed registry associations but extensive use is made of the practice known as "impregnation." This consists of collecting the final portion of the ejaculate as the stallion dismounts and, with a syringe and inseminating tube, injecting it through the cervix of the mare just covered, with the object of increasing the changes of conception.

In the past, horse semen was considered to be extremely fragile and satisfactory results were thought to be obtainable only when it was used within a few minutes of collection. Now it can be stored effectively for up to 24 hours using egg yolk-glucose dilutors. It has also been successfully frozen. Normally the semen collected at one service from the stallion can be diluted to artificially breed about 15 mares.

For insemination, a glass syringe attached by a rubber adapter to a disposable inseminating tube is commonly used. The lubricated gloved hand containing the inseminating tube is passed into the vagina, the cervix located with the index finger, and the tube passed through the cervix. Insemination is thus made directly into the uterus. The optimum time for insemination can best be assessed by following the development of the follicle by rectal palpation. Another method is to estimate the time of ovulation from the appearance of the vagina and cervix as seen through a vaginal speculum.

It should be kept in mind that sperm are severely harmed by water, acids, soaps, metals, cold shock, and high temperatures. Thus, attempts should be made to avoid contamination of semen with any foreign materials, and careful temperature control should be maintained at all times.

3) Artificial Insemination in Sheep

Except in Russia, the technique of artificial insemination of sheep has not passed much beyond the experimental stage. It has not found wide application in the sheep industry in the United States because the demand for it has not yet arisen. Until the problem of storage is solved, it will be necessary that semen be collected from rams when and where it is to be used.

Ewes in heat are identified by vasectomized rams carrying some suitable "marker" device on the brisket. Preferably, ewes should be inseminated during the latter half of the heat period and while the vaginal mucous is thin and clear in appearance.

For insemination, the ewe is restrained to limit movement and to present the hindquarters at a convenient height for easy access to the vagina. The cervix is located with the aid of a speculum and suitable light, and the insemination is made as deeply as possible into the cervical canal. In inseminating ewes 0.05 to 0.2 cc diluted semen containing 50 to 100 million sperm is recommended for deposition in the cervix.

4) Artificial Insemination in Swine

Artificial insemination of swine is still in the experimental stage in the United States, but there is great interest in its potential. The techniques involved have been developed to the point where artificial insemination is realiable and technically simple.

In sows, ovulation occurs normally about 40 hours after the onset of heat. The optimum time for insemination occurs about 16 hours before ovulation and coincides with the time during heat when most gilts and sows will tolerate heavy pressure on the loin area. Inseminations performed at this time will result in a farrowing rate of about 75%, while inseminations at other times result in 30 to 40% conception rate.

At insemination a disposable plastic pipette is inserted into the cervix, keeping the pipette against the dorsal surface of the vagina. The semen is slowly forced into the uterus from a plastic squeeze or syringe. In swine, 20 to 50 cc of fresh semen diluted at a rate of 1 part of semen to 1.5 to 5 parts of diluent has given reasonable conception rates. Careful heat checks and patience during insemination are essential for good results.

9. Animal Health and Sanitary Precautions

Transparency No. 15a

Based on present knowledge gained through research and practical observation, it may be concluded that stockmen can make artificial insemination more successful by observing the following:

a. Animal Health

1) Don't breed back too soon. In cows, wait 60 days before rebreeding. Mares may be bred back on foal heat (7 to 100 days after foaling), provided foaling was normal and no infection occurred; otherwise, wait 25 to 30 days. Sows should be bred back in 35 to 49 days. Ewes are normally bred to lamb at a specific season depending on the market situation and are not bred back immediately after lambing.

2) Avoid breeding diseased females or females showing infectious discharges.

3) Have males inspected at regular intervals by a competent veterinarian and pronounced free of transmissible diseases.

4) Have females examined that have been bred three times without conception or that show other reproductive abnormalities.

5) Keep records of heat periods and note irregularities.

b. Sanitary Precautions

Transparency No. 15b

1) All semen collection equipment should be clean and sterile.

2) All glassware with which semen is to come in contact should be clean and sterile.

3) Follow strict refrigeration recommendations for handling semen both after collection and before insemination.

4) The inseminator-technician should make certain that all equipment used in the insemination process is completely sterilized.

5) Disposable equipment such as plastic sleeves, plastic inseminating tubes, etc. should be placed in a suitable receptacle to avoid possible contamination of other animals on the farm.

WHY BREED ARTIFICIALLY ?

A. MAXIMUM USE OF OUTSTANDING SIRES

B. GREATLY INCREASED UNIFORMITY

C. POSSIBLE TO OVERCOME CERTAIN PHYSICAL HANDICAPS TO MATING

D. LESSENS SIRE COST

E. ALLEVIATES DANGER AND BOTHER OF KEEPING A SIRE

F. REDUCES THE COST AND DELAYS OF USING INFERTILE SIRES

G. BETTER HEALTH PROTECTION

H. IMPROVED HERD RECORDS

I. INCREASES PROFITS

J. INCREASES PRIDE OF OWNERSHIP

TM-1

LIMITATIONS OF ARTIFICIAL INSEMINATION

A. REQUIRE SKILLED TECHNICIAN

B. MUST CONFORM TO PHYSIOLOGICAL PRINCIPLES

C. MAY RESTRICT THE SIRE MARKET

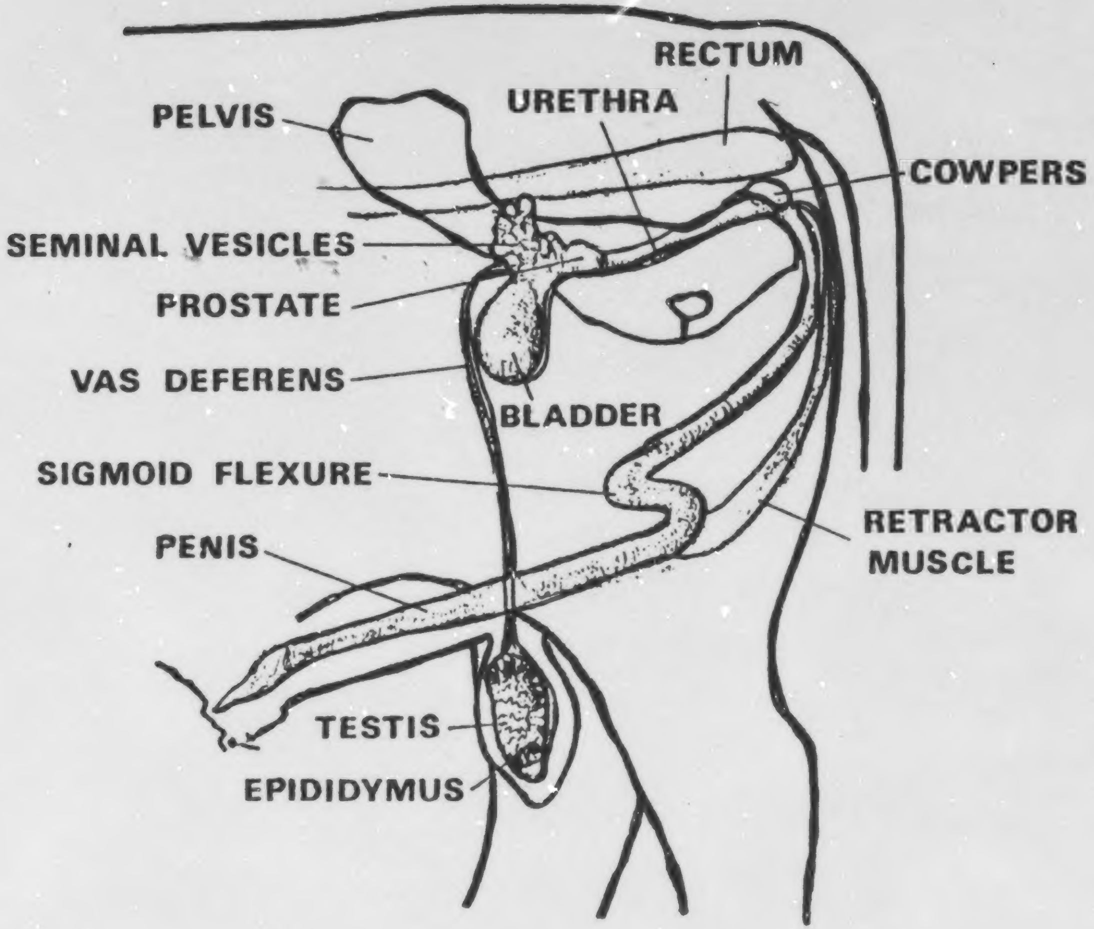
D. MAY INCREASE THE SPREAD OF DISEASE

E. MAY BE SUBJECT TO CERTAIN ABUSES

F. MAY ACCENTUATE THE DAMAGE OF A POOR SIRE

G. CONSIDERABLE CAPITAL AND COMPETENT MANAGERIAL ABILITY ARE NECESSARY TO INITIATE AND OPERATE AN ARTIFICIAL BREEDING ORGANIZATION

MALE REPRODUCTIVE TRACT


RECTUM
URETHRA
PELVIS
COWPERS
SEMINAL VESICLES
PROSTATE
VAS DEFERENS
BLADDER
SIGMOID FLEXURE
RETRACTOR MUSCLE
PENIS
TESTIS
EPIDIDYMUS

AgIII-III-145

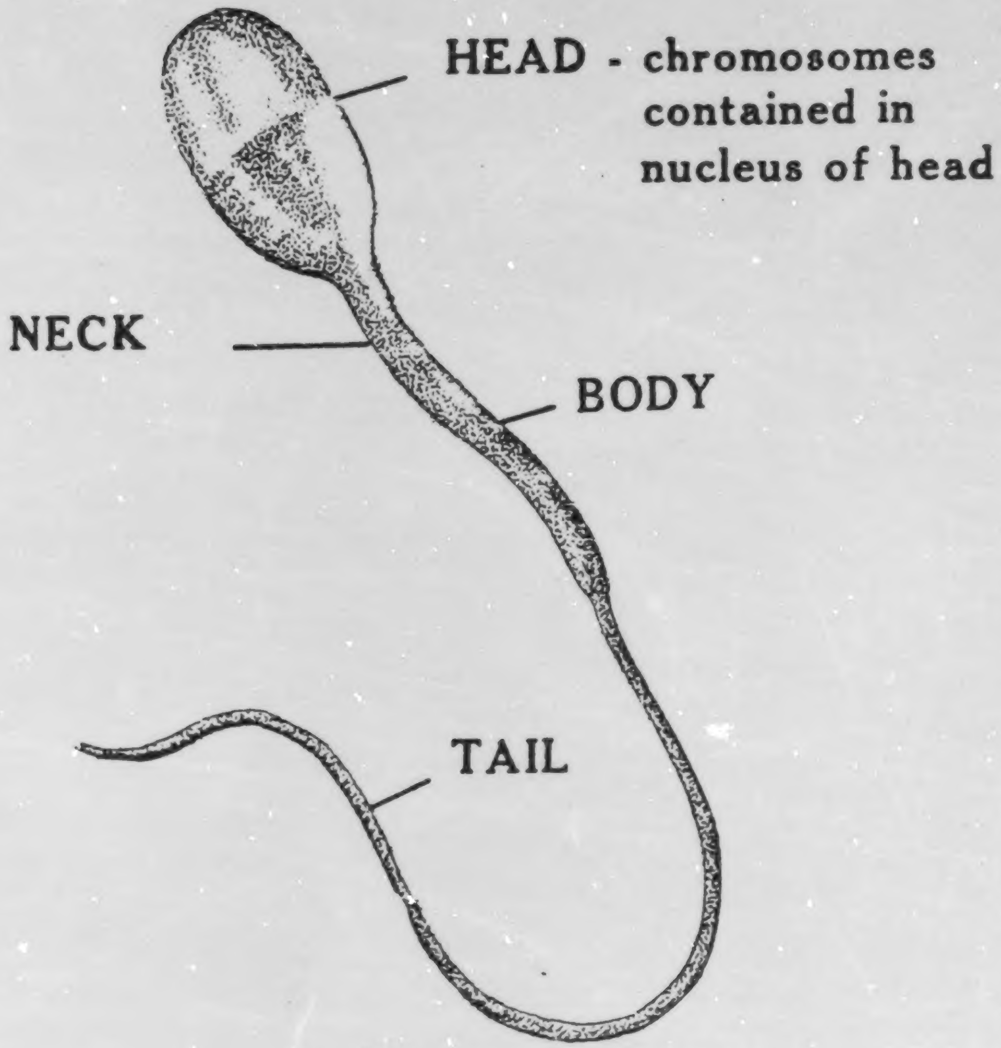
TM-3

SEMEN VOLUME & NUMBERS FOR FARM ANIMAL SPECIES

Animal	Vol. per Ejaculate (ml.)	Sperm per mm. (1,000's)	Total Sperm per Ejaculate (billions)
boar	150-250	100	15-25
bull		1,000	3-5
rooster	0.6-0.8	3,000	1.8-2.4
ram	0.8-1.0	1,000	0.8-1.0
stallion	70-100	100	7-10

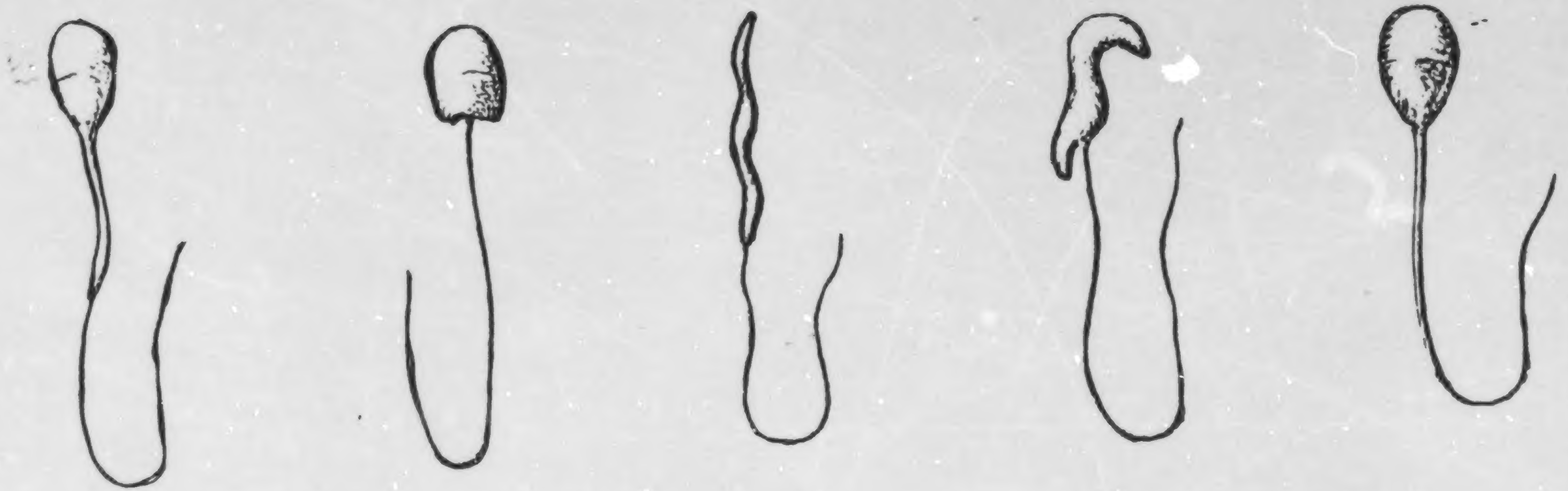
	No. Females Bred per Ejaculate
boar	10-12
bull	100-600
rooster	
ram	40-100
stallion	8-12

ANATOMY OF SPERM


HEAD - chromosomes contained in nucleus of head
NECK
BODY
TAIL

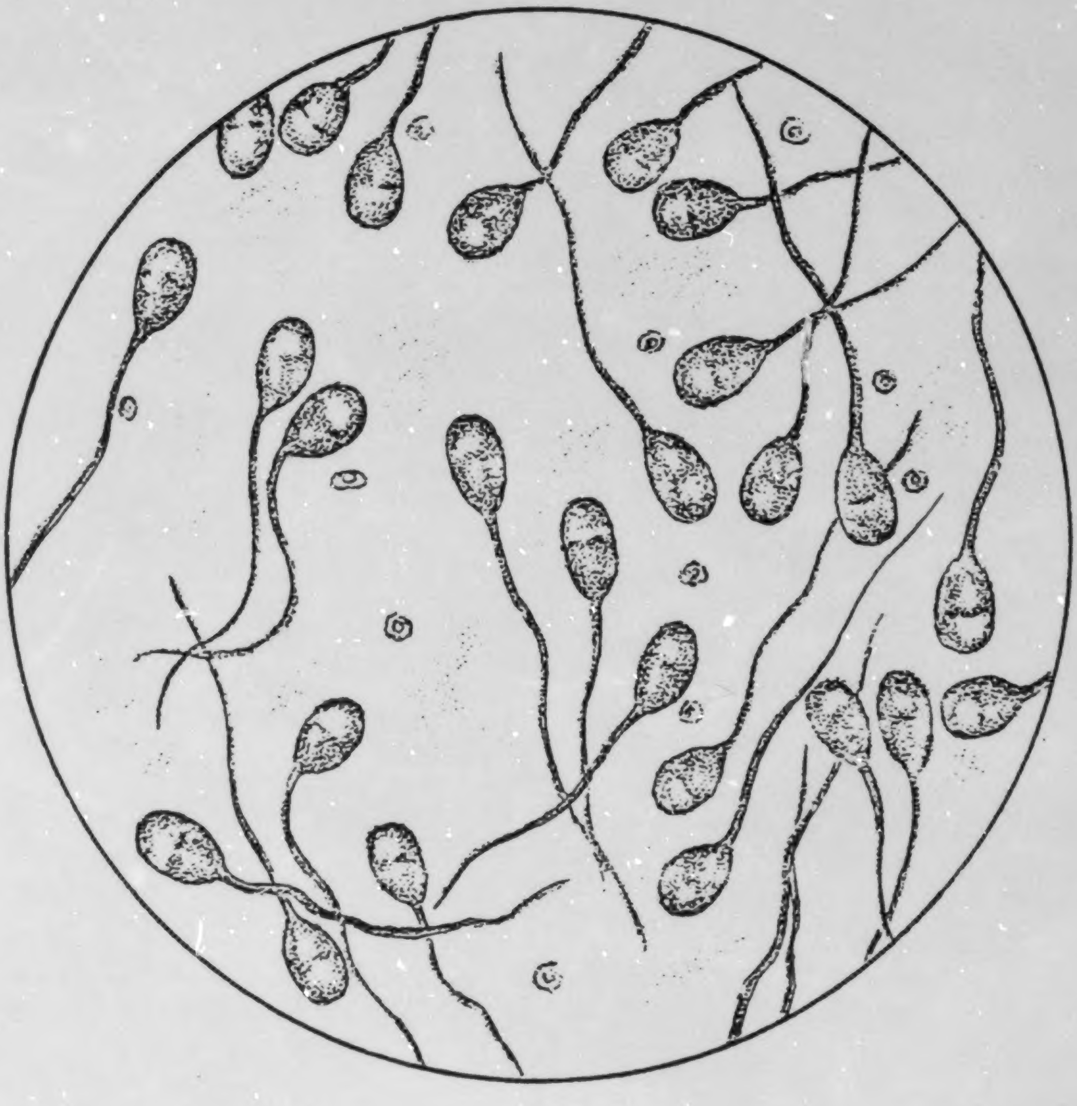
AgIII-III-148

SPECIES DIFFERENCES IN SPERM ANATOMY


BULL
SHEEP
CHICKEN
RAT
GUINEA PIG

TM-5b

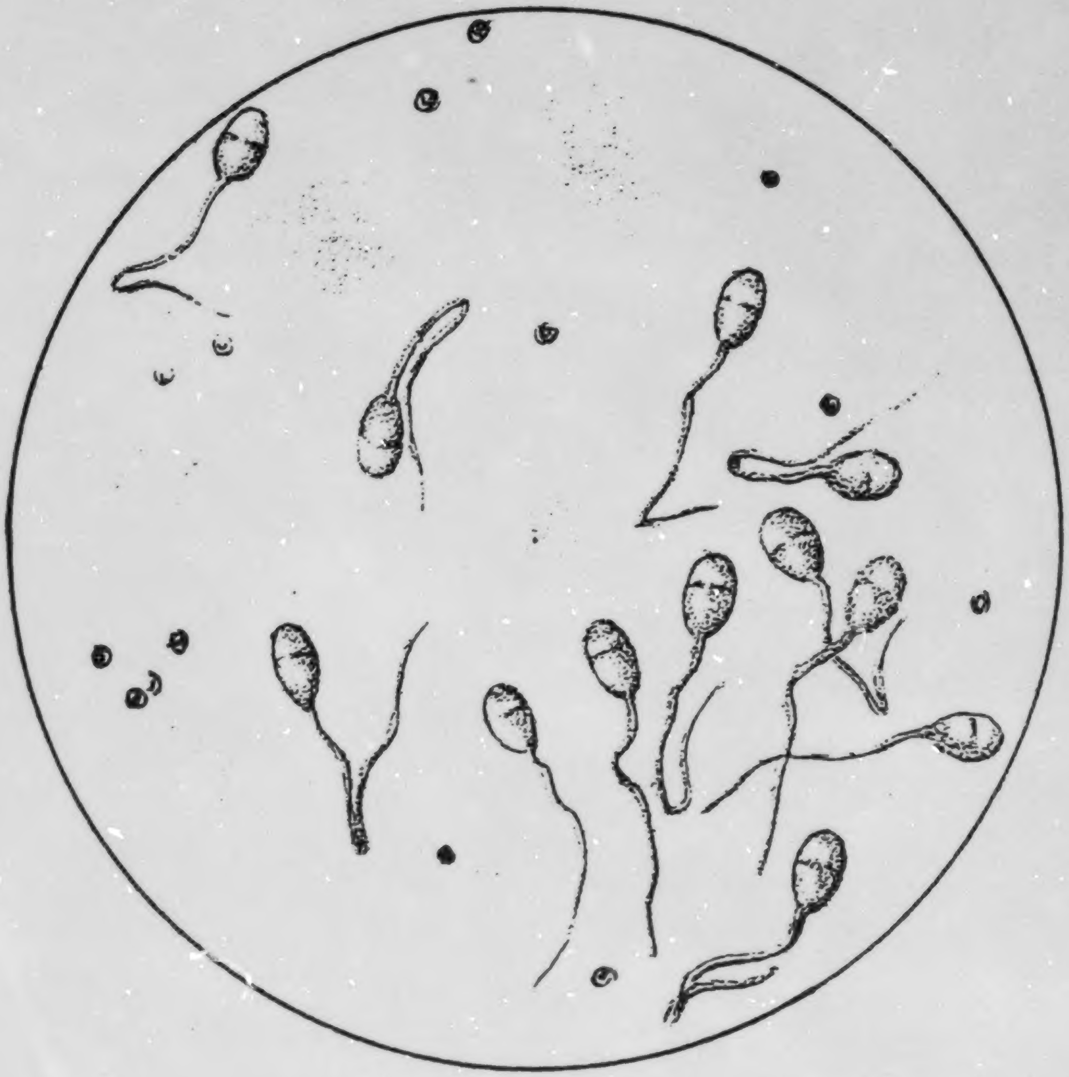
GOOD SEMEN



TM-6 a

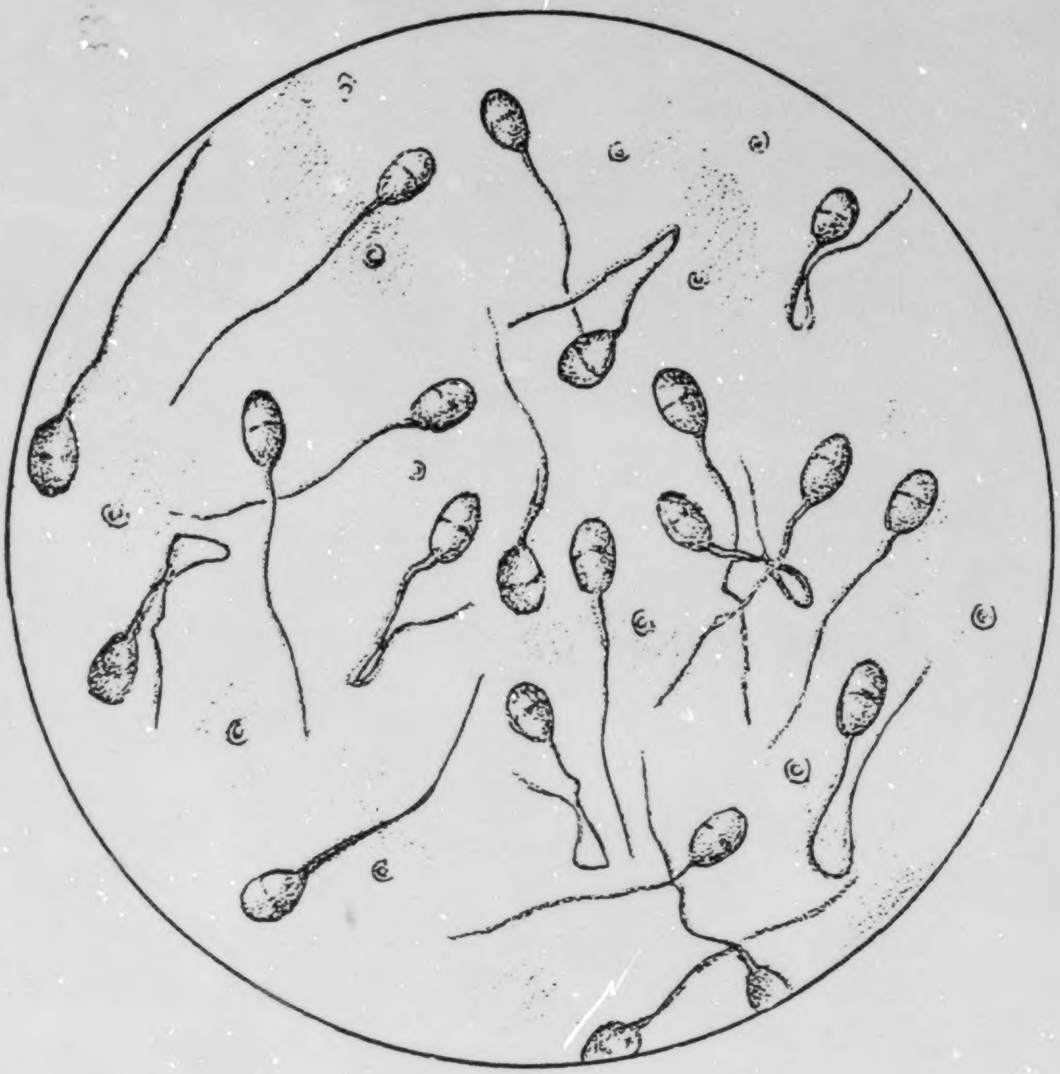
AgIII-III-150

POOR SEMEN



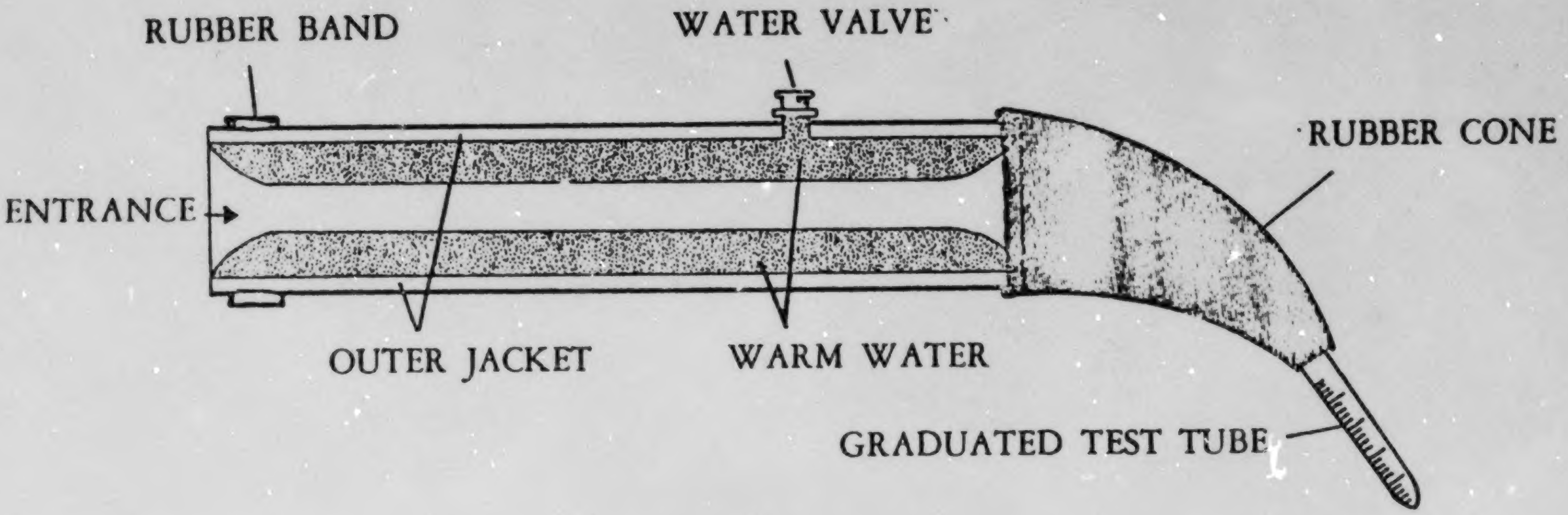
TM-6b

QUESTIONABLE SEMEN

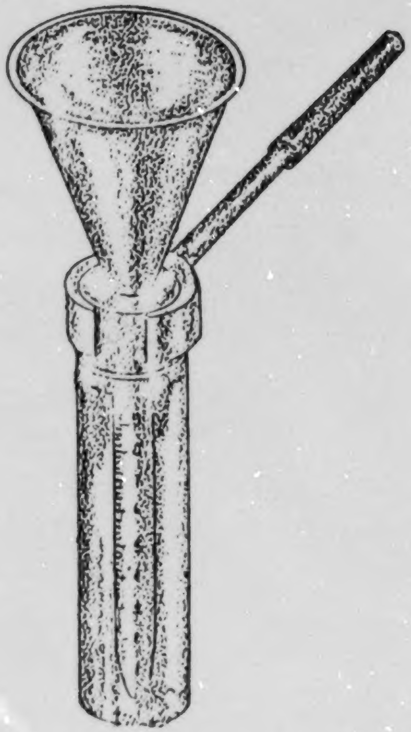


TM-6c

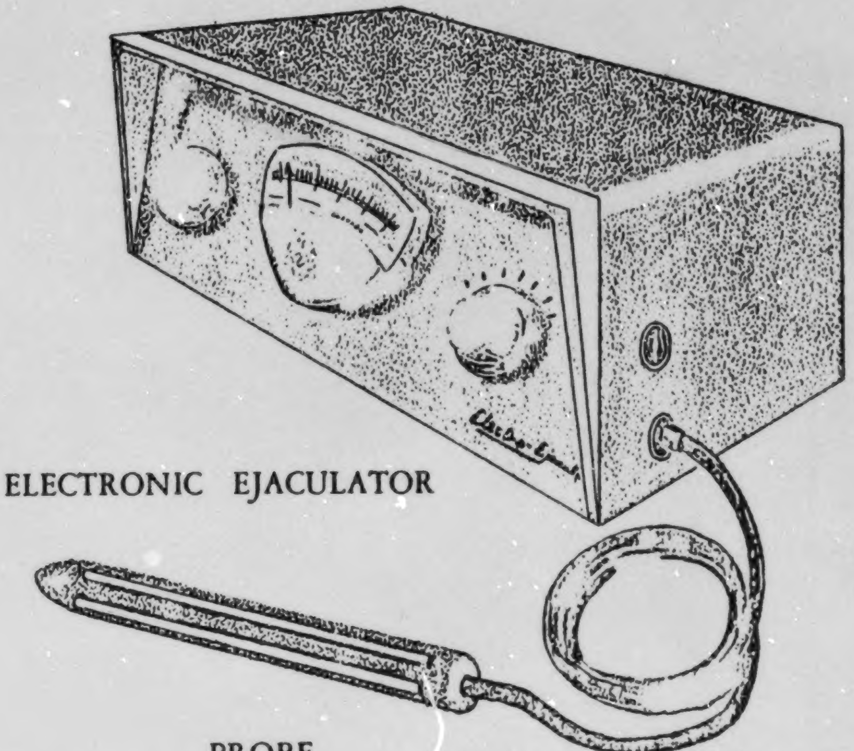
ARTIFICIAL VAGINA


RUBBER BAND
WATER VALVE
RUBBER CONE
ENTRANCE
OUTER JACKET
WARM WATER
GRADUATED TEST TUBE

ELECTRONIC SEMEN COLLECTION EQUIPMENT



COLLECTION HANDLE
AND VIAL



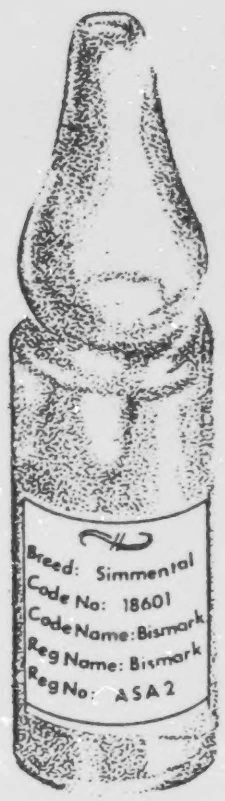
ELECTRONIC EJACULATOR

PROBE

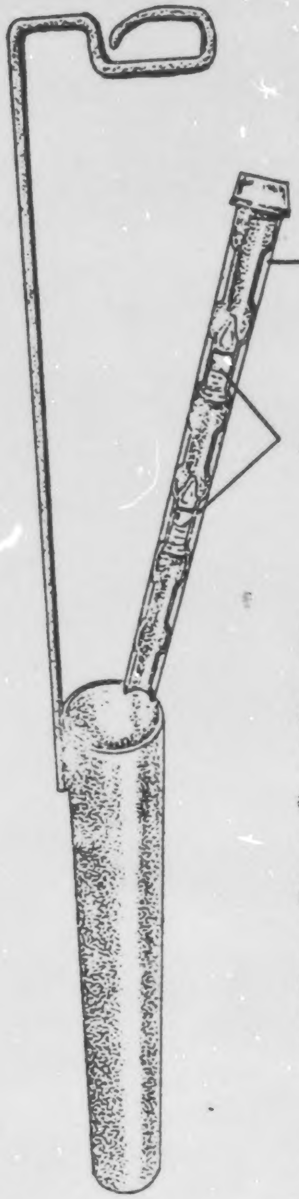
SEMEN DILUTERS

Type of Diluter	Classes of Animals Used For	Comments
1. egg yolk-citrate	bull,ram	1 part fresh egg yolk to 3 parts 2.9% sodium citrate dihydrate in distilled water.
2. egg yolk-phosphate	bull ,ram,stallion	mix equal parts of fresh egg yolk and chemically pure sodium hydrophosphate-hydrate or (appropriate phosphate solution)
3. homogenized whole milk	bull, ram,boar	boil fresh homogenized whole milk for 5 to 10 minutes. then cool to body temperature and dilute with equal parts of distilled water.
4. glycine-containing diluents	boar	formula-50% of a 4% glycine solution, 42.5% skim milk, and 7.5% egg yolk

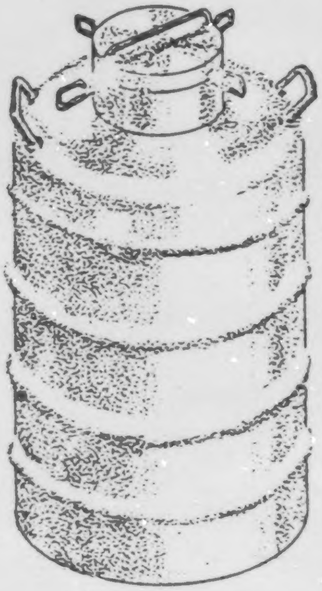
SEMEN AMPULING AND STORAGE


Breed: Simmental
Code No: 18601
Code Name: Bismark
Reg Name: Bismark
Reg No: ASA 2

SEMEN AMPULE

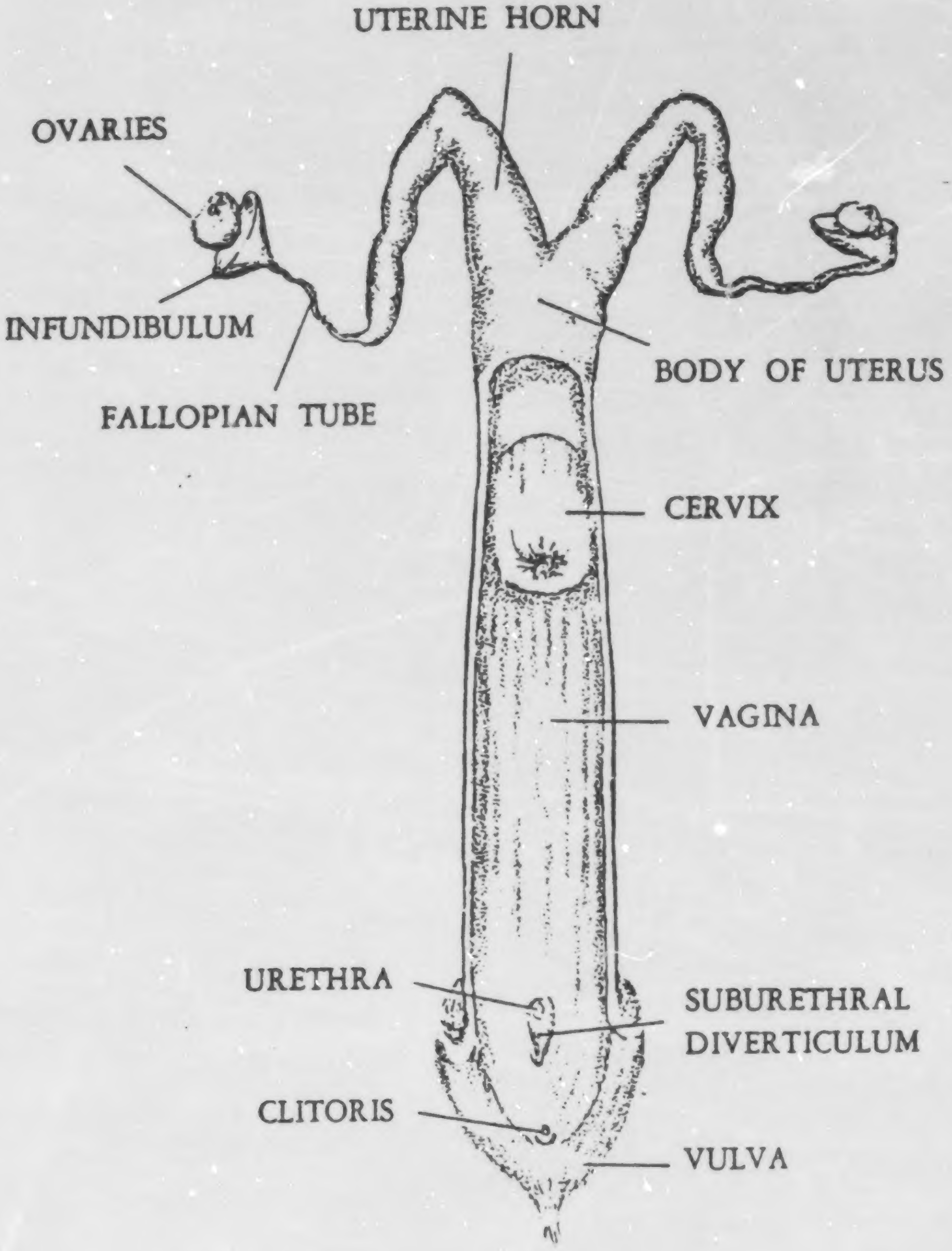

AMPULE CANE
AMPULES

CANISTER



LIQUID NITROGEN
STORAGE CONTAINER

FEMALE REPRODUCTIVE TRACT
(top view)

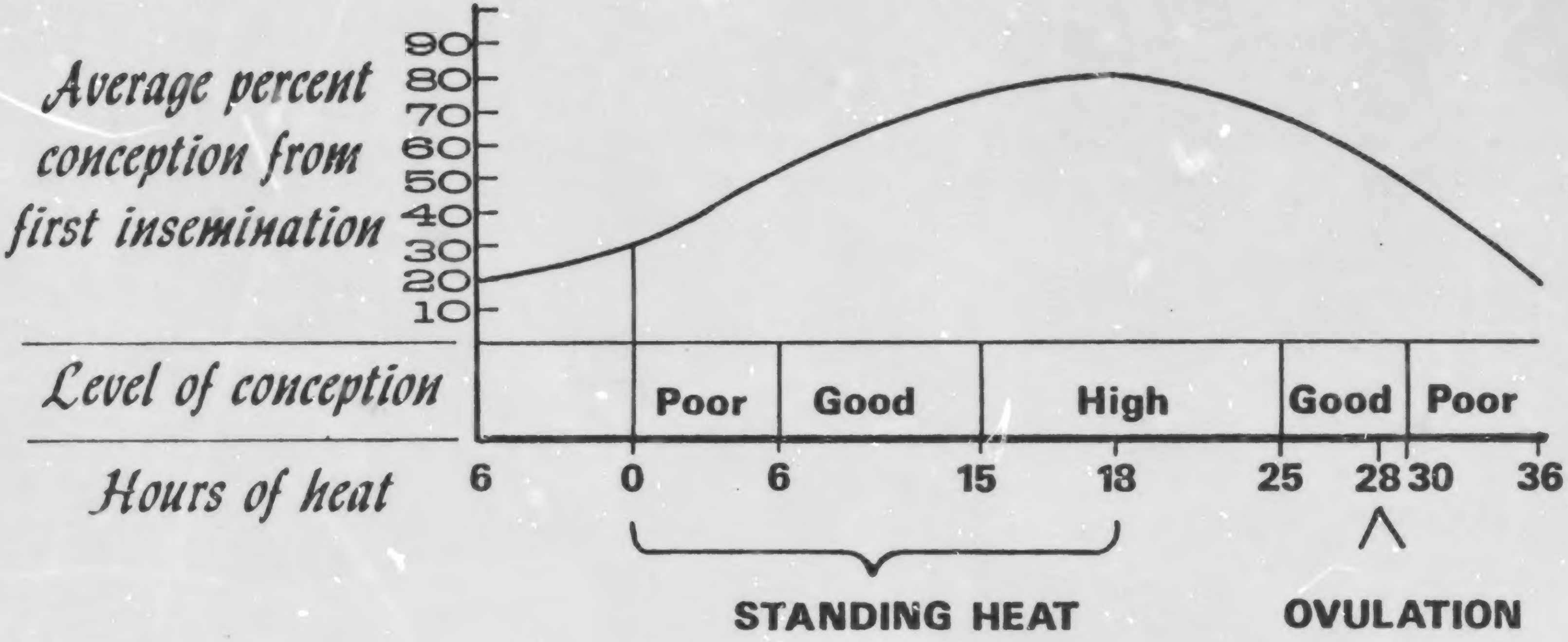

UTERINE HORN
OVARIES
INFUNDIBULUM
FALLOPIAN TUBE
BODY OF UTERUS
CERVIX
VAGINA
URETHRA
SUBURETHRAL DIVERTICULUM
CLITORIS
VULVA

THE REPRODUCTION CYCLE IN FARM ANIMALS

Species	Length of Estrus Cycle (days)		Length of Estrus		Usual Time of Ovulation	Length of Gestation (days)		Age at Puberty (months)
	av.	range	av.	range		av.	range	
mare	21	10-37	5-6 days	1-14 days	24-48 hrs. before end of estrus	336	310-350	10-12
cow	19-21	16-24	16-20 hrs.	8-30 hrs.	10-14 hrs. after end of estrus	281	274-291	4-8
ewe	16	14-20	30 hrs.	20-42 hrs	1 hr. before end of estrus	150	140-160	4-8
sow	21	18-24	1-5 days	1-5 days	18-60 hrs. after estrus begins	112	111-115	5-7

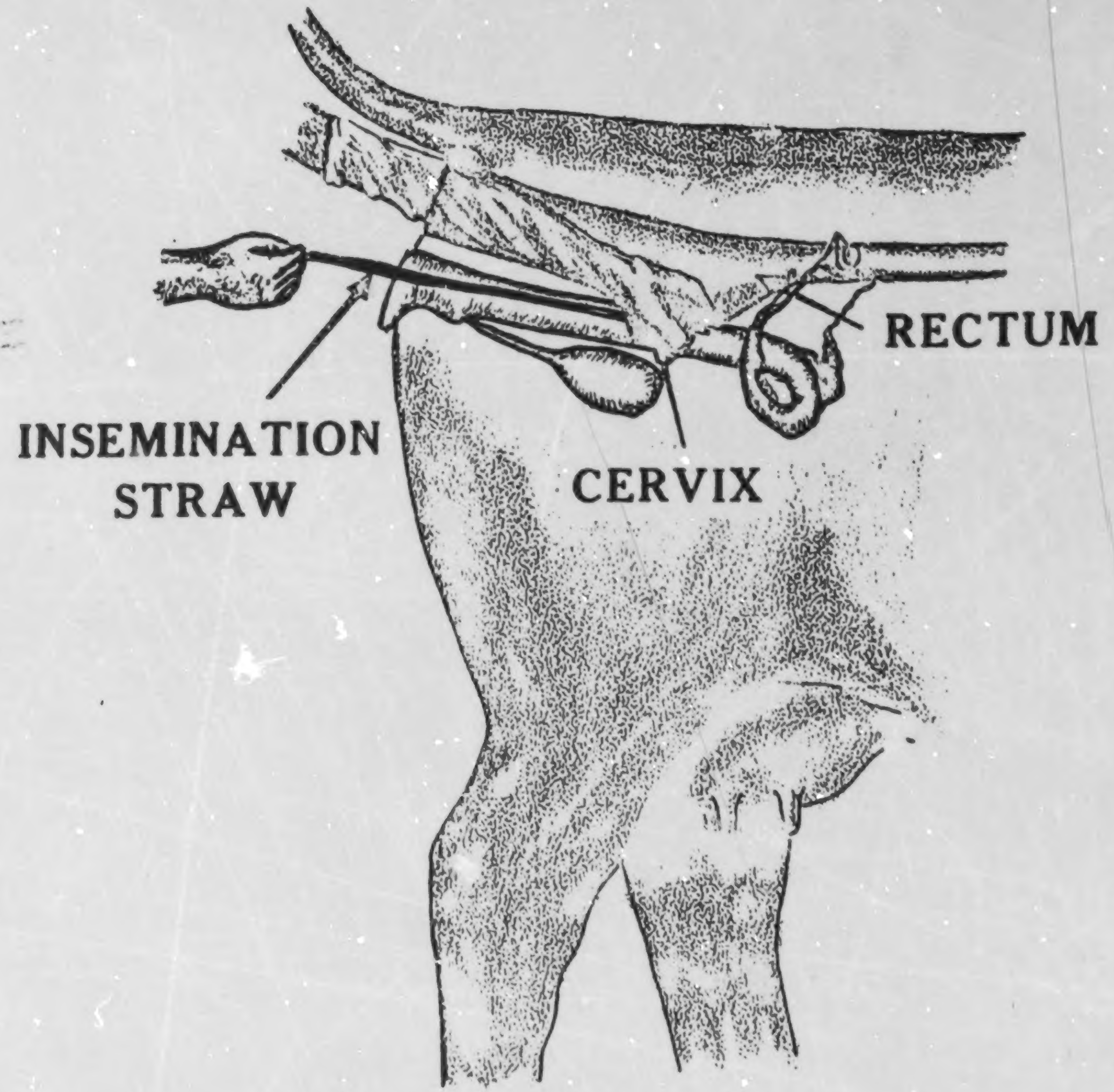
AgIII-III-158

TIME OF BREEDING AND CONCEPTION RATE IN CATTLE



TM-13

ARTIFICIAL INSEMINATION


RECTUM
INSEMINATION STRAW
CERVIX

ANIMAL HEALTH PRECAUTIONS IN ARTIFICIAL INSEMINATION

1. DON'T BREED BACK TOO SOON
2. AVOID BREEDING DISEASED FEMALES
3. HAVE MALES INSPECTED AT REGULAR INTERVALS
4. HAVE FEMALES INSPECTED THAT HAVE NOT CONCEIVED AFTER THREE BREEDINGS
5. KEEP RECORDS OF HEAT PERIODS AND NOTE IRREGULARITIES

SANITARY PRECAUTIONS IN ARTIFICIAL INSEMINATION

1. STERILIZE ALL SEMEN COLLECTION EQUIPMENT
2. CLEAN AND STERILIZE ALL GLASSWARE FOR SEMEN HANDLING
3. FOLLOW STRICT REFRIGERATION REGULATIONS FOR HANDLING SEMEN
4. COMPLETELY STERILIZE ALL INSEMINATION EQUIPMENT
5. MAKE PROPER DISPOSAL OF ALL DISPOSABLE EQUIPMENT

ANIMAL SCIENCE

Unit 2: Livestock and Poultry Diseases

Lesson 1: Bacterial, Viral, Nutritional, Fungal, and Miscellaneous Diseases (7 hours)

Suggested Procedures and Activities: Students could be expected to make class reports on the different diseases, and the class may wish to visit a local veterinary clinic to observe actual cases of diseases.

1. Importance of Livestock and Poultry Diseases

Disease is defined as any malfunction preventing the animal from functioning normally. A diseased animal cannot be expected to be a reliable source of profit to the farmer. The United States Department of Agriculture estimates the annual loss to poultrymen in the United States from poultry diseases and parasites to be in excess of 365 million dollars. Losses of production, lowered efficiency, and deaths due to animal diseases and parasites total over 2.4 billion dollars annually.

Transparency No. 1

2. Causes of Disease

Most diseases of farm animals are either introduced by new animals being brought onto the farm or as a result of poor sanitation and management practices by the farmer. Since it is any malfunction, disease may be the result of a variety of causes. Most common farm animal diseases result from one or more of the following:

Nutritional Defects - Most nutritional diseases are caused by a lack of balance among the required food nutrients. Animals require specific amounts of fats, carbohydrates, proteins, minerals, and vitamins: too little or too much of any of these nutrients may produce undesirable reactions in farm animals.

Physiological Defects - This type of defect refers to a particular body gland, organ, or system. There is a close interrelationship between the diet of a farm animal and the proper functioning of that animal. For example, the thyroid gland, which regulates the general rate of body metabolism, is dependent on a proper amount of iodine to function normally. The rate of metabolism affects the amount of food nutrients required by an animal for normal maintenance.

An improperly functioning thyroid gland may increase the animal's maintenance requirements to the point that very few nutrients are available for growth or production. The animal's rate of gain, growth, and production may, at least in part, be reduced as a result of an improperly functioning thyroid gland.

Morphological Defects - Physical defects of animals are generally the result of an accident or negligence on the part of the farm manager. Their injuries include the cuts, scrapes, scratches, bruises, and broken bones that decrease the efficiency of the animal. Good management practices are necessary to prevent these accidental injuries.

Practicing farm neatness will help to prevent accidental injury to many farm animals. Loose wire, old lumber, equipment, and other odds and ends should be disposed of or properly stored. Protruding nails and broken boards in working and loading areas can cost farmers money through injuries and should be eliminated.

Transparency No. 2

Proper handling of livestock during loading, feeding, or working can prevent many harmful bruises and scrapes that would reduce the market value of the animal. Suitable equipment relieves not only stress and injury to the animals, but also to the farmer. Clubs and whips should not be used to work livestock; canvas slappers are just as effective and will not damage or bruise the animal. Proper bedding should be used when hauling livestock. Slippery footing can result in broken bones and bruises, which lower the market value of farm animals. Care should be taken to protect the animals from the weather while hauling.

Pathogenic Organisms - Pathogens are the living things that are capable of producing a disease: they generally produce some type of toxin or poison that upsets the normal metabolic activity of the animal. The most common pathogens, viruses, and bacteria, are microscopic in size and have the capabilities of multiplying rapidly in the optimum environmental conditions. Many of the fungi produce diseases of economical importance to the farmer.

Virus diseases are probably the most difficult to control because the virus so closely resembles the basic, inherited chemical compound of a cell (DNA); therefore, it is difficult to find a chemical that will kill or control the virus without destroying the host cell. Preventative vaccination has been the most successful method for controlling virus diseases.

Bacteria are microscopic organisms responsible for many diseases. Bacteria produce powerful toxins and are capable of rapid multiplication (reproduction). Many of the pathogenic bacteria are capable of forming spores, resistant forms of a bacterial cell, that are capable of withstanding severe environmental conditions. This spore is very difficult to control and may be dormant for years before being provided with the opportunity to cause a disease. (See Tetnus). Antibiotics, chemicals produced by organisms, which prevent or retard the growth of other microorganisms, have been successful in keeping most bacterial diseases under control.

Fungal diseases are caused by small organisms called fungi. Many fungi live in the soil and are capable of producing diseases. Bacteria are often classified as a type of fungi, and it is often difficult to determine the actual cause-agent in fungal diseases because bacteria are often responsible for secondary infections.

Transparencies No. 3, 4, 5, and 6

3. Characteristics of Common Diseases

Anemia - All farm animals

Cause - Anemia, caused by a deficiency of iron in the diet, is a nutritional disease of all classes of farm animals. It may also result from an insufficient total volume of blood, or from a failure of the red marrow of the bones to manufacture blood. Nutritional anemia is the most common form.

Symptoms - Anemia is characterized by a general weakness and a lack of vigor and energy. A deficiency of iron in the ration limits the formation of hemoglobin by the body. Hemoglobin is a red, iron-containing pigment in the red blood cells that is responsible for carrying oxygen to the cells. This lack of oxygen for the cells limits the release of energy needed by the animal.

Prevention and Control - Providing a complete, balanced ration will usually prevent the occurrence of anemia. Once encountered, anemia may be treated by the addition of iron-rich feeds to the ration.

Bloat - Most common to cattle

Cause - Bloat, a common disorder of cattle which sometimes affects sheep and goats, is an accumulation of gases, believed to result from bacterial action, in the animal's stomach. This acute form of indigestion may be caused from overeating, consuming spoiled feeds, or the occlusion of the fore stomach.

Symptoms - The most noticeable symptom is a distended or swollen abdomen on the left side of the animal. Loss of appetite, stiffness, and groaning are common symptoms of a bloated stomach.

Prevention and Control - Although there is some evidence to indicate that susceptibility to bloat may be inherited, proper management practices are helpful in preventing the occurrence of bloat. Bloat is most likely to occur when hungry cattle are turned on lush, green legume pastures. Providing pastures with both grasses and legumes, and feeding dry feeds (hulls and meal) before turning cattle on lush green pastures help to prevent bloat. The bloating of animals on dry concentrates may be prevented by changing their feed.

Bloat is usually treated by drenching the animal with mineral oil and by keeping the animal on its feet and moving. Severe cases of bloat may require puncturing the paunch to release trapped gases.

Colic - Common to horses

Cause - Colic is a nutritional ailment that most often affects horses and is primarily caused by improper feeding. Colic is one of several forms of intestinal indigestion. Bloat, impaction, and constipation are most commonly associated with colic and may result from overfeeding, a sudden change in feed or feeding habits, or excessive drinking following heavy work.

Symptoms - Colic is most often characterized by pain, sweating, and constipation. Affected animals will kick, paw, and in severe cases, roll and thrash about in a reckless manner.

Prevention and Control - Requesting the assistance of a veterinarian is recommended in treating severe cases of colic; but the animal should be kept on its feet until help arrives. Sedatives and laxatives are generally prescribed. Because colic most often results from improper feeding practices, it is best prevented by careful feeding.

Enterotoxemia - A common sheep disease

Cause - Bacteria and overeating combine to cause enterotoxemia (over-eating disease) in sheep. Overeating of grains and other concentrates by sheep allows the rapid growth of an intestinal bacteria which produce a deadly toxin.

Symptoms - Lambs are sluggish and apt to go off feed. Constipation, an early symptom, is usually followed by diarrhea. Some sick animals may stagger about or show signs of convulsions.

Prevention and Control - There is no completely effective treatment for enterotoxemia, and animals that recover are generally slow to return to feed. Veterinary assistance is needed for an early diagnosis of the disease, so that measures may be taken to prevent its spread. A bacterin or antitoxin vaccine is available and effective in providing immunity, but good management and feeding practices are important in preventing the occurrence of enterotoxemia.

Founder - Common to horses

Cause - Founder is a nutritional disease commonly affecting horses, but other classes of livestock may be affected. The ailment commonly follows heavy overeating of grains.

Symptoms - Although it is most often caused by overeating, founder results in a deterioration of the hoof. Affected animals are in pain, have fever, and are hesitant about moving.

Prevention and Control - Proper management and feeding procedures are necessary for preventing founder, although some animals do show a tendency to founder regularly. Animals should be allowed to cool and calm themselves before being fed. Should an animal founder, veterinary assistance is recommended; the animal's feet should be bathed in cold water until the veterinarian arrives.

Cholera - Most common in swine

Cause - Hog cholera, perhaps the most important of the swine diseases, is caused by a virus. For many years, bacteria were believed to be the cause of cholera; this mistake slowed progress toward finding an effective control.

Symptoms - Hog cholera is extremely infectious and contagious and affects all ages of swine. The first signs of cholera are loss of appetite and fever. Affected animals, being listless and droopy, tend to remain separated from the rest of the herd. In some cases, a reddish-purplish patchwork of coloration is visible on the hog's stomach.

Prevention and Control - A preventative vaccination is available for hog cholera and should be given at an early age. Veterinary assistance and advice are recommended any time cholera is involved. There is no effective treatment. Proper sanitation is of extreme importance in preventing the occurrence and/or spread of cholera.

Equine Encephalomyelitis - Primarily affects horses and mules

Cause - This disease is caused by a virus and may affect many kinds of animals and man. It is generally transmitted by blood-sucking insects, the mosquito in particular. To be transmitted from one animal to another, the disease must have a carrier.

Symptoms - Most horses that have sleeping sickness develop fever, have a sleepy appearance, walk about aimlessly, and grind their teeth. The sluggish animal may move awkwardly and show signs of muscle spasms.

Prevention and Control - Control of carrier agents is a prerequisite to successful prevention of encephalomyelitis. Mosquitos are probably the most common carriers. A preventative vaccination is available and is recommended prior to the peak outbreaks of the season. The services of a veterinarian should be used in treating cases of sleeping sickness.

Hemorrhagic Septicemia or "Shipping Fever" - All classes of livestock

Cause - Shipping fever is believed to be caused by a microorganism which is an inhabitant of the respiratory system. For some reason, not fully understood but particularly common during periods of stress, this organism multiplies rapidly and produces shipping fever.

Symptoms - Fever, difficult breathing, and coughing are common in affected animals. Discharges from the eyes and nose may be visible. These symptoms may vary depending on the locality of the infection.

Prevention and Control - Prevention is difficult and best accomplished by vaccinating with a bacteria prior to shipping, moving , or other periods of stress. Affected animals are usually treated with sulfanilamide and antibiotics.

Pneumonia - All class of livestock

Cause - Pneumonia may be caused by infections of various kinds of microorganisms; it is most often caused by viruses or bacteria. Pneumonia, often contacted after the animal's resistance has been lowered by a disease, is a common secondary infection. As a primary disease, pneumonia is usually associated with chilly, damp, drafty conditions.

Symptoms - General dullness, failing appetite, and high temperature are common symptoms of pneumonia. Difficult and noisy breathing are also visible signs of the disease.

Prevention and Control - Improper housing and ventilation must be corrected as a prerequisite to preventing pneumonia. Although pneumonia is not always highly contagious, proper sanitation is necessary to help prevent the occurrence and spread of the disease. Sulfamethazine has been the most effective drug for treating the disease.

Newcastle Disease - Poultry disease

Cause - Newcastle, a highly contagious respiratory disease of chickens, is caused by a virus; it may also affect the nervous system. The virus is believed to be spread by droppings, litter, or direct contact.

Symptoms - Coughing, sneezing, gasping, fever, and watery diarrhea are symptoms of newcastle. A sudden drop in production and abnormally developed eggs characterize newcastle in the laying flock. Mortality rate in baby chickens may be high but is usually less than 10 percent of the laying flock. Paralysis, spasms, and a loss of equilibrium are signs of newcastle disease's affects on the nervous system.

Prevention and Control - Antibiotics have been used successfully as a treatment in early stages of the disease. Survivors of the disease are immune. A newcastle vaccine will effectively prevent the disease. The producer should purchase chickens from reputable hatcheries and maintain a good program of sanitation.

Tetanus - All classes of livestock

Cause - A specific bacterium which forms spores in livestock is responsible for the disease. The tetanus spore, renewing its normal mode of life when in contact with the living tissues of an animal and usually through some wound, may lie dormant for years. As the bacteria reproduces and produces its toxin, the symptoms of tetanus appear.

Symptoms - A tetanus infected animal has stiff muscles, difficulty swallowing, and occasional muscle spasms. Livestock usually have an "extended" or "stretched" appearance.

Prevention and Control - Careful cleansing of wounds is important in preventing tetanus. Careful nursing is required to enable an infected animal to survive. Tetanus toxoid provides about a year's immunity; an injection of tetanus antitoxin provides fast protection, but is of short duration.

Anthrax - All classes of livestock

Cause - Anthrax is caused by a spore-forming bacteria. This spore can survive many years in the soil; the organism may also be found in contaminated carcasses bones, and intestinal discharges of animals.

Symptoms - Anthrax often results in a quick death; fever, swelling in the lower-body regions, and a bloody discharge may be visible. Suffocation due to swelling in the neck may cause death.

Prevention and Control - Anthrax is a highly contagious disease and very dangerous to all warm-blooded animals and man. Carcasses should be buried very deep and covered with lime, or they may be burned. It is impossible to do this too quickly, and it should be done without opening the carcass. Treatment during early stages with large doses of antibiotics, such as penicillin, has been successful. A vaccine of some value is available for healthy animals.

Chronic Respiratory Disease (CRD) - Chickens

Cause - Authorities are not in complete agreement on the cause of CRD, but the concensus of opinion is that it is caused by a virus or virus-like organism. The disease commonly affects brooder chickens and may be spread from hen to the chicks through the hatching of eggs. Extreme, sudden temperature changes may provide conditions suitable for an outbreak of CRD.

Symptoms - Chronic respiratory disease has symptoms similar to other respiratory diseases; it stunts growth, increases mortality rate, and decreases production 20 to 30 percent in laying hens. Feed consumption is reduced, and chickens become weak and thin.

Prevention and Control - Since there is no vaccine for CRD, prevention depends primarily on good management and good sanitation practices. Stress factors and sudden temperature changes should be avoided. Antibiotics, being used with limited success in treating the disease, should be fed at low, continuous, levels.

Warts - Primarily affects cattle

Cause - Warts, being contagious, are caused by a virus. They may vary in number and size. Increased numbers of large warts will create an unthrifty condition in cattle. Warts lower the quality of the hide, thus they are of economic importance.

Symptoms - Warts are visible, protruding growths on the skin, and are most commonly found around the head and neck.

Prevention and Control - Prevention includes segregating "warty" cattle to prevent spreading the disease. Warts may be surgically removed by a veterinarian. Daily applications of a light oil to soften the wart has been successful in some instances. An effective preventative vaccine is available.

Atrophic Rhinitis - A disease of swine

Cause - A specific cause for rhinitis has not been isolated, but it is known to be contagious, especially in young pigs; it spreads by direct contact.

Symptoms - Rhinitis, resulting in a twisted, wrinkled snout, affects the bone structure of the nasal passages. Early symptoms usually include sneezing. The affected pigs are usually runty. Pneumonia or a secondary infection may be contacted during advanced stages of the disease.

Prevention and Control- No effective treatment is available for rhinitis. Infected animals should be isolated to prevent spreading the disease. Disinfectants should be used regularly.

Blackleg - Affects cattle primarily

Cause - A spore-forming bacteria, which lives rather permanently in contaminated areas, is responsible for the disease. The germ is generally taken into the body via contaminated soil or water.

Symptoms - Lameness is usually one of the first signs of blackleg. The infected areas, usually a body quarter, become swollen as a result of the collection of gas under the skin. These swellings usually produce a crackling sound when pressed. Young animals are most commonly affected.

Prevention and Control - There is not an effective treatment; however, a preventative vaccine is available and should be administered when the animal is 3 to 4 months of age. Animals over two years old are usually immune. Infected carcasses should be disposed of by burying and covering with lime or burning.

Brucellosis - Affects all classes of livestock

Cause - Brucellosis, sometimes called Bangs, is caused by bacteria. These bacteria have varied capabilities for survival and may be transmitted to other cattle through the genitals, digestive tract, or the conjuctiva.

Symptoms - This highly contagious disease is most often characterized by abortion of the immature fetus. A blood test is required for a more positive identification. Some cattle will react positive to the blood test, yet will not show any symptoms of the disease.

Prevention and Control - Wide-spread organized efforts have been made to control brucellosis, and restrictions generally prevent the sale of infected animals for any purpose other than slaughter. An effective calfhood vaccination is available. A further explanation of control methods is provided later in the discussion of government restrictions.

Distemper - Common to horses

Cause - Distemper, a contagious disease, is caused by a bacteria. Unhealthy, unthrifty, young animals are most likely to become infected by distemper.

Symptoms - The disease is usually first characterized by fever, which is followed by depression, loss of appetite, and a discharge of pus from the nose. Glands, particularly those under the jaws, may become inflamed and eventually will break open and release the accumulated pus.

Prevention and Control - Affected animals should be quarantined and their quarters disinfected. Generally, no permanent affects of distemper will be seen if treated properly in the early stages. Sulfa drugs, antibiotics, and B vitamins are used in treating the disease.

Swine Enteritis - A swine disease

Cause - Enteritis, an intestinal inflammation, is caused by several species of bacteria infecting the large intestine. Some authorities believe a vitamin B deficiency promotes the occurrence of this disease. The enteritis form of swine dysentary often accompanies hog cholera to create an extremely serious and hazardous condition.

Symptoms - Most hogs infected with enteritis are unthrifty and have diarrhea. Fever may be present during early stages of the disease but will usually disappear shortly. Enteritis may become chronic and produce a constant, unthrifty condition.

Prevention and Control - Newly purchased animals should be quarantined before being released with the herd. Nitrofuran, NF-180, mixed with the feed, has been effective in controlling the disease during its early stages. Sulfa drugs and antibiotics have proven beneficial during the latter stages of the disease. Quarters should be cleaned and disinfected regularly. Careful management and good sanitation can eliminate the occurrence of most cases of enteritis.

Erysepelas - A swine disease

Cause - A resistant bacteria is responsible for this disease in swine; it may also affect other classes of livestock. The germ, causing new outbreaks of the disease, is able to survive many months in barnyard manure and litter.

Symptoms - There are three recognized forms of erysepelas: acute, subacute, and a "diamond skin" form. Acute erysepelas symptoms include high temperature, constipation, diarrhea, and reddish patches on the skin of the lower body. A high mortality rate accompanies the acute form. The subacute form is usually localized in organs such as the heart, bladder, or joints. Sloughing off of the skin may occur with "diamond skin" form of the disease. These areas may develop secondary infections making the animals unthrifty.

Prevention and Control - Proper sanitation and the quarantining of infected animals is important in preventing the occurrence and spread of the disease. An anti-swine erysepelas serum, which has a curative affect on the acute form and stimulates a natural immunity, is available.

Leptospirous - May infect all classes of livestock

Cause - A bacteria commonly found in the blood, urine, and milk of infected animals is the cause of leptospirous. The urine of infected animals may be responsible for contaminating the water, food, and surroundings, and spreading the disease.

Symptoms - "Lepto" is often characterized by abortions or sterility. Other symptoms are blood-tinged milk and/or urine. Many times the symptoms of leptospirous go unnoticed with little visible ill-effects on the animal; but generally, production and breeding are influenced.

Prevention and Control - Infected cattle should be quarantined until they can be disposed of. Newly purchased animals should be blood-tested to determine if they are infected. A preventative vaccine is available and may be successful in preventing the disease when used in conjunction with proper management and sanitation. Antibiotics have been effective in treating some cases.

Tuberculosis - All classes of livestock

Cause - TB is caused by different strains of bacteria, which may be spread by contaminated food, water, and air. The tuberculosis bacteria may also be spread through contaminated milk.

Symptoms - The disease may infect different areas of the body although TB most often affects the lungs. Infected animals are usually unthrifty and may have a cough. Still others may show no visible signs of the disease.

Prevention and Control - Maintaining proper sanitation and adequate living quarters are about the only preventative measures. A vaccination is available; however, its use is not always successful. Two laboratory tests are available for diagnosing TB. Careful nursing and good management are as effective as any other treatment.

Coccidiosis - Poultry disease

Cause - A protozoan is responsible for causing coccidiosis. It is spread by the dropping of infected birds and is easily transmitted from bird to bird in this manner.

Symptoms - The disease occurs in two forms: cecae and intestinal. Cecae coccidiosis is acute in that it develops rapidly and causes a high mortality rate. Bloody droppings and sudden death are symptoms. Intestinal coccidiosis is chronic in nature, and its symptoms are loss of appetite, weakness, pale comb, and low production; few deaths occur.

Prevention and Control - There is not a treatment once the disease is contracted. It may be prevented by maintaining sanitary conditions and feeding a coccidiostat.

Pullorum - Poultry disease

Cause - Pullorum is caused by germs capable of living for months in damp, sheltered places. The germ infects the ovary and is transmitted to the chicken through the egg. The droppings of infected birds will contaminate litter, feed, and water and serve to spread the disease.

Symptoms - Infected chickens usually huddle together with eyes closed and have drooping wings, ruffled feathers, and foamy droppings. A bacteriological examination is required for positive identification. Mortality rate often reaches 50 to 75 percent.

Prevention and Control - Prevention is the only sure control, although sulfa drugs or antibiotics may prove beneficial as treatment. Chickens should be purchased from a certified pullorum-free hatchery.

Foot Rot - Affects all classes of livestock

Cause - A fungi common to filth is responsible for foot rot. Animals are most apt to contract foot rot when they are forced to live in wet, muddy, unsanitary lots for long periods of time.

Symptoms - The skin near the hoof-line is red, swollen, and often shows small lesions. Most animals soon become lame. In the later stages of the disease, there may be a discharge of pus and a foul odor. Severe foot damage may result if this condition goes unchecked.

Prevention and Control - Maintaining clean, well drained lots is an easy method of preventing foot rot. The disease may be treated by moving the animal to clean, dry quarters and bathing the infected animal's feet in a 5 to 20 percent bluestone (copper sulfate) solution for 5 minutes at 2 to 4 days' interval. Advanced stages of the disease will require treatment by a veterinarian.

Calf Diptheria - Young calves and feedlot cattle

Cause - Diptheria is an infectious fungal disease of cattle housed in barns or kept in lots. It does not commonly occur in pasture cattle. The germ lives in litter and enters the body through small scratches or wounds.

Symptoms - Affected animals show difficulty in breathing, eating, and drinking. Patches of yellowish, dead tissue appear on the edges of the tongue, gums, and throat.

Prevention and Control - The diseased tissue should be removed to expose the healthy tissue; this tissue should be swabbed with tincture of iodine. Sulfa drugs and/or antibiotics may be helpful in treating the disease. Affected animals should be isolated to prevent contamination.

4. Prevention

Prevention is the key to controlling animal diseases, and sanitation is the key to prevention of diseases. Most disease-causing agents enter the body through some type of body opening such as the nose, eyes, mouth, or through a wound. Pathogens may be spread by direct contact or indirectly by the wind, water, feed, or animal carriers. After entering the host, the pathogen must overcome the body's natural resistance to produce the disease. A management program that is designed to maintain an environment that prevents or restricts the growth of pathogens, provides a balanced diet, and protects animals against accidental injury is the best possible method of combating animal diseases. Sanitation is the most important phase of management that will aid in preventing the growth of pathogens. Other ways of preventing disease are listed in transparency no. 5.

Transparency No. 7

Certain standards, regarding the living quarters of animals, must be maintained to keep farm animals thrifty and healthy.

a. Housing must provide adequate space for all animals. Crowded conditions tend to promote the incidence of disease.

b. Ventilation must provide adequate fresh air and assist in controlling the temperature. Fresh air needs to be circulated throughout the living quarters without creating drafts.

c. Drainage is important in maintaining suitable living quarters. The producer must keep dirt floors, as well as other kinds, dry and clean. This means that proper bedding must be supplied, and the timely disposal of manure must be maintained.

d. Pasture rotation is a practical method of controlling many diseases and parasites on the open range. A systematic change of pastures has many advantages to the producer. It improves the pasture grasses by providing a growing period, and it may break the life cycle of pathogens by removing the host. Sunlight is the producer's most natural friend. The ultra-violet rays in sunlight kill many pathogens.

e. Disinfectants. Chemicals that aid in restricting the growth of pathogens should be used regularly. Soap and boiling water are two common and inexpensive disinfectants available to most farmers. Some other disinfectants are as follows:

Transparency No. 8

Disinfectants

NAME	USES	LIMITATIONS
Alcohol	Against less resistant cells provided there is adequate exposure.	Not reliable for sterilization.
Creosoles	Generally effective against organisms causing brucellosis, tuberculosis, and hog cholera.	Odor may be absorbed easily and is not effective against spores.
Hypochlorites	For deodorizing manure, animal discharges, and as a general disinfectant.	Not effective against TB organisms, and spores.
Iodine	Skin disinfectant for minor cuts.	Basically limited to small areas on living tissue.
Lime	Used on manure, animal discharges, and as a deodorant.	Not effective against TB organisms or spores.
Soap	Used to clean area prior to application of disinfectant. Aids in dissolving protective coatings.	Not effective as a disinfectant.

Government Regulations

Governmental regulations controlling the transportation and sale of diseased animals in Oregon are strict and complex. It is exceedingly important that the farmer recognize the assistance available to him through his local veterinarian. It is not usually necessary for the farmer to call for a veterinarian's service to treat sick animals; but through visits with and by the use of the veterinarian, the farmer can become aware of the symptoms of some of the diseases most likely to affect his animals. A veterinarian can provide valuable assistance to the farmer in developing a sound program of disease prevention. The local veterinarian is the farmer's closest source of information for governmental regulations that affect livestock producers.

The following is a simplified guide of the governmental regulations that affect the transportation and sale of livestock.

CAUSES OF DISEASE

NUTRITIONAL DEFECTS—**result from unbalanced diets**

PHYSIOLOGICAL DEFECTS—**improper functioning of body parts**

MORPHOLOGICAL DEFECTS—**physical disabilities**

PATHOGENIC ORGANISMS—**tiny living things capable of causing disease**

VIRUSES- sub-microscopic organisms, not complete cells

BACTERIA- microscopic, one-celled, usually classified as plants

FUNGI- small heterotrophic plants, often found in the soil

PROTOZOA- microscopic, one-celled animals

HANDLING LIVESTOCK

Use canvas slappers rather than clubs or whips

Eliminate protruding nails and broken boards

Remove machinery and equipment from the feedlot

Dehorn cattle

Use proper bedding in barns and trucks

Load animals slowly and carefully

Load wisely - use partitions to separate classes of livestock

Protect livestock from weather

NUTRITIONAL DEFECTS

DISEASE	SYMPTOMS	PREVENTION AND CONTROL
ANEMIA	LISTLESS, LACK OF ENERGY	REQUIRES A BALANCED DIET CONTAINING ADEQUATE AMOUNTS OF IRON.
BLOAT	SWELLING OF PAUNCH, SHOWS ON LEFT SIDE	PREVENT RAPID FILLING ON LEGUME PASTURES. DRENCH WITH MINERAL OIL. KEEP ANIMAL ON FEET AND MOVING.
COLIC	RUMBLING IN STOMACH, KICKING, ROLLING, AND CONSTIPATION	PREVENTED THROUGH PROPER FEEDING AND EXERCISE. SEDATIVES AND LAXATIVES ARE PRESCRIBED.
ENTEROTOXEMIA	CONVULSION, SLUGGISH, DIARRHEA, STAGGERS, LOSS OF APPETITE	EFFECTIVE TREATMENT NOT AVAILABLE. VACCINATION AND GOOD FEEDING PRACTICES ARE BEST PREVENTION.
FOUNDER	PAIN, FEVER, LAMENESS	BATHE FEET IN COLD WATER, CALL VETERINARIAN. DO NOT FEED EXTREMELY HOT OR TIRED ANIMALS BEFORE THEY ARE COOLED AND RESTED.

PATHOGENIC ORGANISMS

DISEASES	SYMPTOMS	PREVENTION AND CONTROL
CHOLERA	DIARRHEA AND/OR CONSTIPATION, FEVER, REDDISH-PURPLE SPOTS ON ABDOMEN	NO EFFECTIVE TREATMENT. GARBAGE SHOULD BE COOKED BEFORE BEING FED TO HOGS. VACCINATION IS AN EFFECTIVE TREATMENT.
EQUINE ENCEPHALOMYELITIS	SLEEPY APPEARANCE, WALK AIMLESSLY ABOUT, GRINDING OF TEETH	REQUIRES A VETERINARIAN'S TREATMENT. A PREVENTATIVE VACCINE IS AVAILABLE.
HEMMORRHAGIC SEPTICEMIA	FEVER, COUGHING, DISCHARGE FROM EYES AND NOSE	MOST OFTEN ENCOUNTERED DURING PERIODS OF STRESS. COMMONLY TREATED WITH ANTIBIOTICS. MAY BE PREVENTED BY VACCINANATION.
PNEUMONIA	CHILLS, FEVER, NASAL DISCHARGE	COMMONLY TREATED WITH ANTIBIOTICS, REQUIRES CAREFUL NURSING
NEWCASTLE	COUGHING, SNEEZING, DIARRHEA, DROP IN PRODUCTION	ANTIBIOTICS EFFECTIVE IN EARLY STAGES. VACCINATION FOR PREVENTION.
TETANUS	MUSCLE STIFFNESS, SPASMS, DIFFICULTY IN SWALLOWING	GOOD NURSING AIDS SURVIVAL. A PREVENTATIVE VACCINATION IS AVAILABLE.
ANTHRAX	FEVER, SWELLING IN NECK, BLOODY DISCHARGES	PENICILLIN MAY BE BENEFICIAL IF DISEASE IS TREATED EARLY. VACCINATION IS AVAILABLE.

PATHOGENIC ORGANISMS (CONTINUED)

DISEASE	SYMPTOMS	PREVENTION AND CONTROL
CRD	RESPIRATORY DIFFICULTIES, LOWERED EFFICIENCY AND PRODUCTION	MANAGEMENT KEY TO PREVENTION. CONTINUOUS LOW-LEVEL ANTIBIOTICS HAVE PROVEN HELPFUL.
WARTS	KNOB-LIKE GROWTHS ON SKIN, PARTICULARLY AROUND HEAD AND NECK	VACCINE HELPFUL IN PREVENTION. MAINTAIN SANITATION TO PREVENT SPREADING.
ATROPHIC RHINITIS	SNEEZING;TWISTED, WRINKLED SNOUT	NO EFFECTIVE TREATMENT. SANITATION HELPS IN PREVENTING THE DISEASE. ISOLATE INFECTED ANIMALS.
BLACKLEG	LAMENESS, SWELLINGS THAT CRACKLE WHEN PRESSED	NO TREATMENT. REMOVE INFECTED ANIMALS. CALFHOOD VACCINATION TO PREVENT DISEASE IS AVAILABLE.
BRUCELLOSIS	ABORTION	NO SUCCESSFUL TREATMENT. BLOOD TEST REQUIRED FOR IDENTIFICATION. SELL INFECTED ANIMALS.
DISTEMPER	DEPRESSION, DISCHARGES OF PUS FROM NOSE AND GLANDS	TREATMENT INCLUDES ANTIBIOTICS AND B VITAMINS. AFFECTED ANIMALS SHOULD BE QUARANTINED.
SWINE ENTERITIS	ROUGH HAIR COAT, DIARRHEA, INTESTINAL DISEASE	TREAT WITH ANTIBIOTICS AND MAINTAIN SANITARY CONDITIONS TO PREVENT SPREADING.

PATHOGENIC ORGANISMS (CONTINUED)

DISEASE	SYMPTOMS	PREVENTION AND CONTROL
ERYSIPELAS	FEVER, EDEMA IN NOSE, REDDISH PATCHES ON SKIN	VACCINATION IS AVAILABLE AS PREVENTION. MAINTAIN SANITATION.
LEPTOSPIROSIS	REPRODUCTIVE DISEASE THAT CAUSES ABORTION	PREVENTATIVE VACCINATION AVAILABLE. ANTIBIOTICS MAY PROVIDE EFFECTIVE TREATMENT. SELL HIGHLY INFECTED ANIMALS. HIGHLY CONTAGIOUS
TUBERCULOSIS	DIFFICULT BREATHING AND UNTHRIFTY CONDITION	NO EFFECTIVE TREATMENT; DISPOSE OF INFECTED ANIMALS; CONTAGIOUS
COCCIDIOSIS	AFFECTS DIGESTIVE SYSTEM, CAUSES DEATH OR UNTHRIFTY CONDITION	MAY BE PREVENTED BY FEEDING A COCCIDIOSTAT AND MAINTAINING SANITARY CONDITIONS.
PULLORUM	CLOSED EYES, DROOPING WINGS, RUFFLED FEATHERS, AND FOAMY DROPPINGS	SULFA DRUGS AID IN CONTROL; PURCHASE ONLY FROM CERTIFIED PULLORUM-FREE BREEDERS
FOOT ROT	LAMENESS; INFLAMATION AND SWELLING OF FOOT	MAINTAIN DRY LOTS AND SANITARY CONDITIONS. BATHE INFECTED AREA IN A COPPER SULFATE SOLUTION.
DIPTHERIA	YELLOWISH, DEAD PATCHES OF TISSUE ON GUMS AND LINING OF MOUTH	REMOVE DEAD TISSUE. PAINT WITH TINCTURE OF IODINE.

LIVING QUARTERS

Provide adequate, clean, well-ventilated housing

Isolate new animals for inspection

Provide a balanced diet

Provide for insect and parasite control

Use disinfectants regularly

Keep area clean and free of debris that may cause injury

DISINFECTANTS

NAME	USES	LIMITATIONS
ALCOHOL	AGAINST LESS RESISTANT CELLS PROVIDED THERE IS ADEQUATE EXPOSURE	NOT RELIABLE FOR STERILIZATION
CREOSOLES	GENERALLY EFFECTIVE AGAINST ORGANISMS CAUSING BRUCELOSIS, TUBERCULOSIS, AND HOG CHOLERA	ODOR MAY BE ABSORBED AND IS NOT EFFECTIVE AGAINST SPORES.
HYPOCHLORITES	FOR DEODORIZING MANURE, ANIMAL DISCHARGES, AND AS A GENERAL DISINFECTANT	NOT EFFECTIVE AGAINST TB ORGANISMS OR SPORES
IODINE	AS A SKIN DISINFECTANT FOR MINOR CUTS	LIMITED TO SMALL AREAS ON LIVING TISSUES
LIME	USED ON MANURE, ANIMAL DISCHARGES, AND AS A DEODORANT	NOT EFFECTIVE AGAINST TB ORGANISMS OR SPORES
SOAP	USED TO CLEAN AREA PRIOR TO APPLICATION OF DISINFECTANTS, AIDS IN DISSOLVING PROTECTIVE COATINGS	NOT AS EFFECTIVE AS A DISINFECTANT

ANIMAL SCIENCE

Unit 2: Livestock and Poultry Diseases

Lesson 2: Importance of Parasites (1/2 hour)

Terms: All terms underlined are in the "Glossary of Terms."

Livestock and poultry losses due to parasites have been estimated at nearly a billion dollars annually in the United States. Parasites affect their hosts in various ways and in different degrees. Some of the ways parasites directly affect their hosts are as follows:

1. By absorbing food
2. By sucking blood or lymph
3. By feeding on cell tissues
4. By obstructing passages in the various systems of animals
5. By causing nodules or growths
6. By irritating the animal
7. By transmitting diseases

From an economical standpoint, man is indirectly affected by the impared growth, lowered feed conversion, decreased production, and deaths of livestock and poultry.

A parasite is any organism living in, on, or at the expense of another living organism. The economically important parasitic organisms of livestock and poultry are fungi, protozoa (single celled animals), helminths (worms), and arthropods (insects, ticks). Bacteria and viruses are parasites but are usually considered with the diseases which they cause.

An animal which serves as a residence for a parasite is called a host. Some parasites require more than one host. Some reside in or on the host throughout the entire life cycle, while others reside on the host only at certain stages during their life cycle.

In general, livestock and poultry parasites are classed as internal or external. Animals' body structures and their excretion of body fluids serve as a repellent for some parasites. However, the host cannot completely combat all parasites; and though they may survive and produce, it is at a lower level. Acquired immunity, either actively through actual contact with the parasite or disease or passively through innoculations from animals having been contacted, is important in combating parasites, although some parasites do not lend to immunity by the host. For example, insects such as hornflies or mosquitos, both blood suckers, are not susceptible to immunization. Therefore, an understanding of the more important parasites, their affects on livestock and poultry, and methods of prevention and control is necessary.

ANIMAL SCIENCE

Unit 2: Livestock and Poultry Diseases

Lesson 3: External Parasites of Livestock and Poultry (2 hours)

Terms: All terms underlined are in the "Glossary of Terms."

External parasites are those parasites found outside of the digestive, respiratory, circulatory, and reproduction systems of animals. External parasites also generally live and reproduce on the external parts of the animals' bodies, with the exception of various stages of development in some parasites. Some external parasites affect only one class of livestock, while others are hosted by several classes of livestock.

Transparency No. 1

1. Ticks

The three different species of ticks that are important in Texas are the lone star, Gulf coast, and spinose ear ticks. They suck blood from their host as well as spread disease. Ticks range in body linght from 1.2 millimeters to 28 millimeters.

Hosts - Ticks attack all classes of livestock. However, they are of the greatest concern to cattle producers. Poultry is not a primary host, but it is sometimes affected.

Life cycle - After leaving the host, the adult lays eggs during a 1 to 2 week period. The eggs hatch into a larvae in 10 days to 3 weeks, but must find a suitable host such as birds or other warm-blooded animals if the cycle is to continue. The larval metamorphosis, depending on the species, is usually completed from a few days to several weeks. The larva changes to a nymph and finds a host where it stays attached until it becomes a mature adult. This period will vary from a few days to several months depending upon the species. The adults find new hosts. After they lay eggs, the adults die.

Damage - The ticks affect animals by sucking blood, carrying diseases, leaving an opening in the animal's skin where other parasites, such as the screwworm, may enter. The tick may produce a serious wound, which may cause injury or a bacterial infection. Severe infestation can cause anemia, loss of weight, and even death.

Symptoms - Ticks may be found on the host animal by visual examination. Animals may become anemic, lose weight, hold head in an abnormal position (caused by ticks in their ears), and rub against fence posts or trees.

Control Measures - Ticks are controlled to some extent by hot, dry climatic conditions and extreme cold temperature. Pasture rotation is used to help control the tick, but this method is not very effective. The most effective method of controlling ticks is by the use of chemical pesticides. Chemicals may be used as sprays, dips, dusts, smears, aerosols, or systemics. Check with local veterinarian for recommended chemical control.

Transparency No. 2

2. Lice

There are four species of lice that attack livestock and poultry. The blood-sucking lice feed by piercing the animal's skin and drawing blood. Biting lice feed on particles of hair, scabs, and excretions from the skin. Heavily infested animals may be weakened by the loss of blood, and become susceptible to disease. Lice also keep livestock from making gains. Infestation is usually lighter in the summer and winter.

Hosts - Though most species attack all classes of livestock and poultry, only one species is found in swine. The dog louse is the largest species found on domestic animals. Poultry lice remain on poultry through their entire life cycle and affect poultry only.

Life Cycle - The adult females glue their eggs to the hairs of the host. The hatching time varies with the species, the area in which the eggs are laid on the animal, and the temperature. The nymphs of lice differ from the adults in size and color. Hatching time of eggs will be 1 to 2 weeks. The eggs are hatched into nymphs; and within 2 weeks to a month, they are mature adults.

Damage - Lick suck blood from animals and can cause them to become anemic, have a rough hair coat, and rub and scratch themselves. Animals lose patches of hair and weight and have reduced rates of gains. Death can be caused by lice.

Symptoms - The primary symptoms of lice are the rough hair coat and the rubbing and scratching.

Control Measures - Because they live most of their lives on the host, cattle lice are more easily controlled than some other parasites. Chemical pesticides can be used most effectively to control lice. The chemicals may be applied as sprays, dips, dusts, and with self-treatment devices. Check with local veterinarian for recommended chemical control.

Transparency No. 3

3. Mites

Scabies, scab, mange, or barn itch is a contagious skin disease caused by mites. The mites which cause scabies live on the surface of the skin.

Hosts - Mites attack all classes of livestock and poultry. Poultry are affected by numerous species of mites, and infestations are sometimes serious enough to cause death.

Life cycle - This parasite spends its entire life on the animal. The adult female lays the eggs on the surface of the skin. The eggs hatch in about 4 days, and the larvae emerge. The larvae molt and become nymphs and later molt again and become adults. The entire life cycle takes 12 days or less time.

Damage - The hair comes out, and the skin becomes very rough and crusty.

Symptoms - Falling hair and rough, crusty, red skin are symptoms.

Control measures - This pest is under United States Department of Agriculture quarantine. Officials should be notified as soon as they are identified or recognized. Check with local veterinarian for recommended chemical control.

Transparency No. 4

4. Screwworm

The larval stage of this parasite eats the live flesh of warm-blooded animals. If it is not controlled, the screwworm will kill the animal. It has for many years cost the cattlemen of Texas millions of dollars each year. Since 1960, an eradication program in the Southwest has helped keep this pest under control.

Hosts - The screwworm affects all livestock and poultry. Infestation is generally only at points of wounds and where blood is available externally. However, some cases have infected animals in the absence of a wound.

Life cycle - The screwworm fly lays eggs on all kinds of wounds; the eggs hatch in 12 to 24 hours, and the tiny maggots feed as a colony in the living flesh. Larvae complete their growth in 5 to 7 days, drop to the ground, burrow into the soil, and pupate. The pupal stage lasts 7 to 10 days in warm weather but may last several weeks in cold weather. Flies emerge from the soil and within a few hours are ready to fly.

Damage - The screwworm, beginning on some type of open wound, eats on live flesh. These pests may cause loss of weight, permanent injury, or death.

Symptoms - The primary sign of screwworms in a wound is an unpleasant odor. The wound will continue to enlarge until the screwworms are controlled.

Control measures - The present eradication program being conducted by Southwest Animal Health Research Foundation, produces male sterile flies and releases them to mate with the females. The female mates only one time. After mating, she lays infertile eggs, which will not hatch. Check with local veterinarian for recommended chemical control.

Transparency No. 5

5. Heel Fly or Cattle Grub

The heel fly, which is the adult stage of the cattle grub, lives only a few days, as it has no mouth parts for feeding. During this period, the female lays eggs on the hairs of the legs and the lower parts of the cattle's bodies. The fly does not sting cattle or cause physical pain; however, it makes a buzzing sound that terrifies cattle and sometimes causes them to harm themselves. During the spring when the heel fly is abundant, cattle may be seen running with their tails curled over their backs or standing in water tanks. This is to escape the flies.

Hosts - Cattle are the primary host for cattle grubs. However, some cases have been found in other livestock.

Life cycle - The heel fly lays eggs on the hairs of the legs and lower parts of the body of cattle. The eggs hatch into larvae which penetrate the hair folicles and enter the animal's body. Over a period of several months the larvae migrate through the animal's body until they reach the back. During this time, the larvae have a high mortality rate; and only a small percentage reach the back.

The grub cuts a breathing hole through the animal's hide, and it feeds on body tissue until it reaches maturity. The grub causes a swelled, pus pocket in the animal's back. After reaching maturity, the grub falls to the ground, burrows into the soil or trash, and pupates. The fly emerges in 1 to 2 months.

Damage - The primary damage is the holes cut in the hide and the damage to the meat, which must be trimmed from the carcass. Also, animals may injure themselves in flight from flies.

Symptoms - The only visible symptom is the swelling of the grubs in the backs of animals.

Control measures - The heel fly cannot be controlled; therefore, the grub must be controlled or killed when it is in the back of an animal. The grubs can be killed while they are in the animal's back, but the best and most effective control measure is the use of systemics. A systemic is a chemical that kills the grubs while they are moving through the animal's body and before they reach the back. Check with local veterinarian for recommendations on chemical control.

Transparency No. 6

6. Horn Flies

The horn fly, being one of the smallest species of flies affecting cattle, is of great economic importance. Although cattle are the major host of the horn fly, they will attack other livestock pastured or stalled with cattle.

Hosts - Cattle are the major host.

Life cycle - The adult lays eggs in manure, and they hatch in about 24 hours. The larvae mature in 5 to 10 days and then pupate. The young flies emerge from the pupae in 3 to 7 days and become adults in a few days.

Damage - Horn flies are found on the head, back, and belly of cattle. They bite and suck blood from the host and cause annoyance to the animal. They suck blood, transmit disease, and indirectly lower rate of gains.

Symptoms - Horn flies are easily seen when the animal is infested. Unless they are controlled, horn flies will cover the backs of cattle during the spring and summer.

Control measures - Most flies can be effectively controlled with the use of recommended chemicals. Feed additives are also available for controlling horn flies. Check with a local veterinarian for recommendations on chemical control.

Transparency No. 7

7. Flies

There are several species of flies that are significant in the livestock and poultry industries. The heel fly, botfly, horn fly, and screwworm fly have been discussed separately due to their economic importance. The species included here are the stablefly, horsefly, blowfly, and housefly, all very closely related. The two ways in which flies affect livestock are by sucking blood and transmitting disease.

Hosts - Flies affect all classes of livestock, and some species affect poultry.

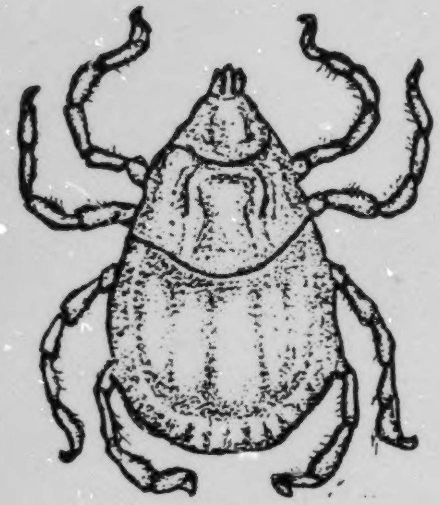
Life cycle - The adult lays eggs in manure, debris, and in the carcasses of dead animals. The eggs hatch in about 24 hours. The larvae mature in 5 to 10 days and pupate. Flies emerge from the pupae in 5 to 7 days and become adult flies within a few days.

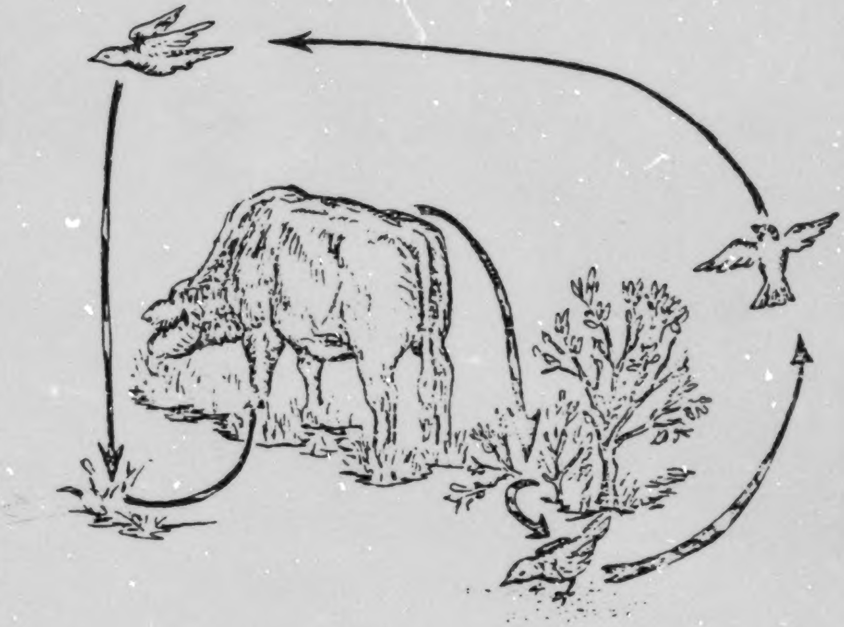
Damage - In addition to biting, sucking blood, and transmitting diseases, flies annoy animals, reduce their gains, and cause a loss of weight.

Symptoms - Flies are easily seen, and heavy infestation are common around barns and lots.

Control measures - Most flies can be effectively controlled with the use of recommended chemicals. Check with local veterinarian for recommendations on chemical control.

EXTERNAL PARASITES





TICKS - THREE SPECIES

A. LIFE CYCLE - EGGS LAID
HATCH INTO LARVAE.
INFECT INTERMEDIATE
HOST, CHANGES TO
NYMPH; INFESTS
HOST, AND BECOMES
MATURE.

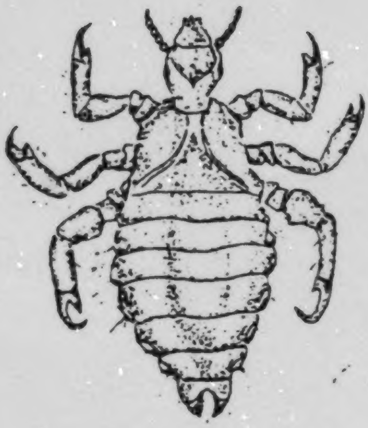
B. HOSTS - ALL CLASSES OF LIVESTOCK

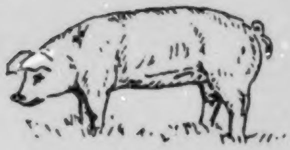
C. DAMAGE - 1. SUCK BLOOD
2. TRANSMIT DISEASE

D. SYMPTOMS - SCRATCHING AND RUBBING

E. CONTROL - CHEMICAL PESTICIDES (SPRAYS, DIPS, DUSTS)

EXTERNAL PARASITES





LICE - 4 SPECIES

A. LIFE CYCLE - REMAIN ON HOST MOST OF CYCLE.

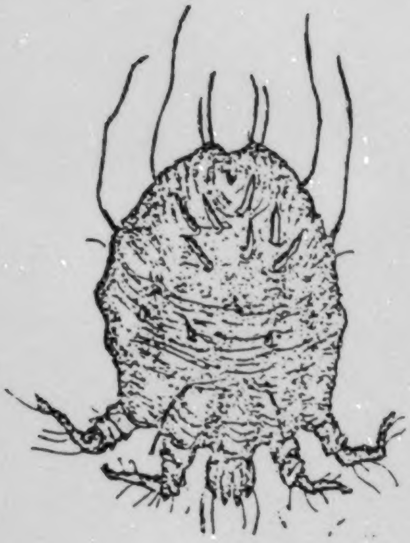
B. HOST - CATTLE, SHEEP, HOGS, HORSES, POULTRY, AND MAN

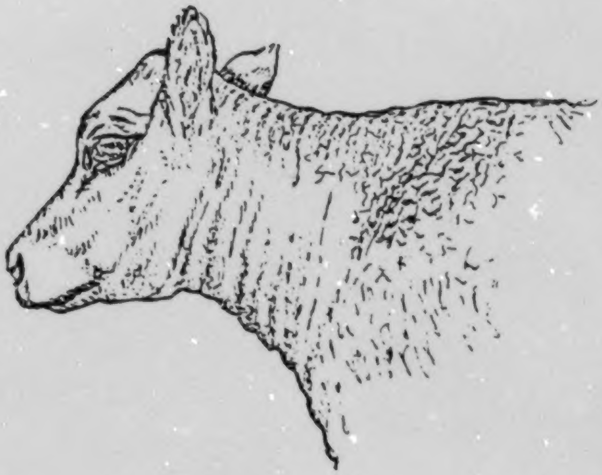
C. DAMAGE -
1. SUCK BLOOD, CAUSE ANIMAL TO BECOME ANEMIC
2. RETARD GROWTH
3. REDUCE PRODUCTION AND RATE OF GAIN
4. LOSS OF HAIR DUE TO IRRITATION

D. SYMPTOMS -
1. ROUGH COAT
2. RUBBING AND SCRATCHING
3. APPEARANCE OF LARGE AGGREGATIONS OF LICE UNDER NECK, AROUND EYES, ETC.

E. CONTROL - CHEMICAL PESTICIDES (SPRAYS, DIPS, DUSTS)

EXTERNAL PARASITES





MITES

A. LIFE CYCLE - REMAIN ON HOST ENTIRE CYCLE.

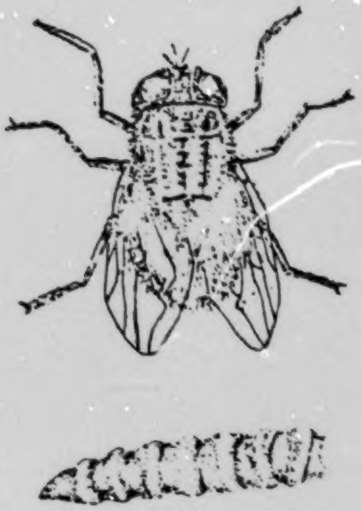
B. HOSTS - ALL LIVESTOCK AND POULTRY

C. DAMAGE -
1. LOSS OF HAIR
2. SKIN BECOMES ROUGH AND CRUSTY

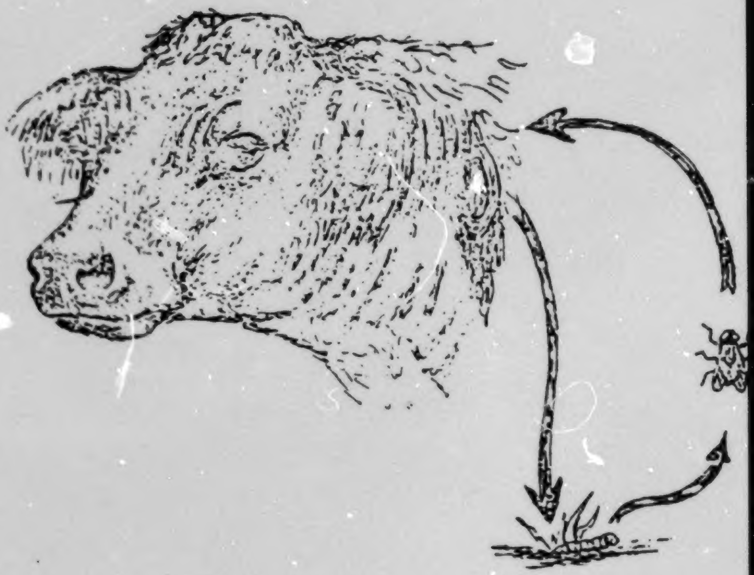
D. SYMPTOMS -
1. HAIR COMES OUT
2. ROUGH, RED IRRITATED SKIN
3. RUBBING AND SCRATCHING

E. CONTROL - CHEMICAL PESTICIDES (SPRAYS, DIPS, DUSTS)

EXTERNAL PARASITES



SCREWWORM - BLOWFLY



A. LIFE CYCLE - EGGS LAID IN ANIMAL'S WOUND, HATCH INTO LARVAE WHICH FEED ON FLESH; AFTER 5 TO 7 DAYS THEY FALL TO THE GROUND AND PUPATE IN 7 TO 10 DAYS; THEN ADULT FLIES EMERGE.

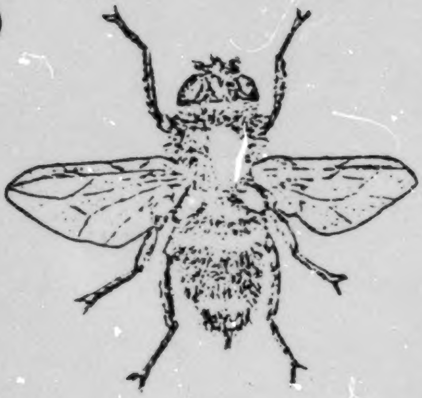
B. HOSTS - ALL LIVESTOCK AND POULTRY

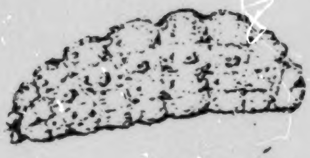
C. DAMAGE - 1. DAMAGE BODY PORTIONS
   2. PERMANENT CRIPPLING
   3. DEATH

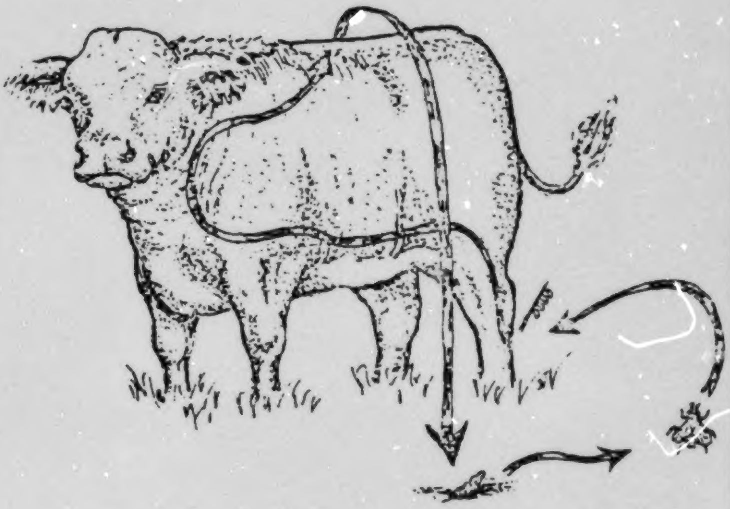
D. SYMPTOMS - 1. UNPLEASANT ODOR OF WOUND
   2. BLEEDING OF WOUND
   3. APPEARANCE OF MAGGOTS

E. CONTROL - 1. GOVERNMENT ERADICATION PROGRAM
   2. CHEMICAL - (SMEARS AND BOMBS)

EXTERNAL PARASITES







HEEL FLY - CATTLE GRUB

A. **LIFE CYCLE** - EGGS ARE LAID ON HAIR; LARVAE HATCH, PENETRATE SKIN, AND TRAVEL TO BACK; WHEN MATURE, THEY FALL TO THE GROUND AND FLIES EMERGE.

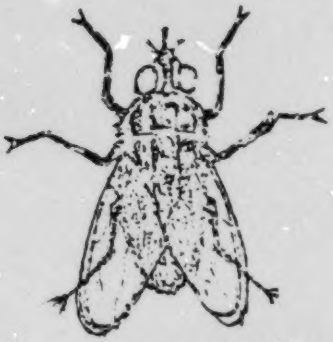
B. **HOSTS** - CATTLE

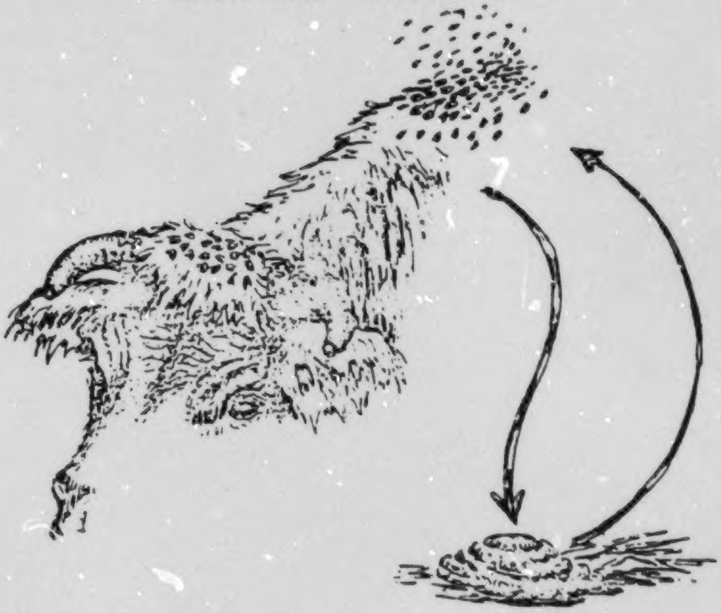
C. **DAMAGE** - 1. DAMAGE TO HIDE AND MEAT
2. INJURY TO LIVESTOCK IN FLIGHT FROM FLIES

D. **SYMPTOMS** - 1. SWELLING IN ANIMAL'S BACK CAUSED BY GRUBS

E. **CONTROL** - CHEMICAL APPLICATION OF INSECTICIDES TO ANIMAL'S BACK

EXTERNAL PARASITES





HORN FLIES

A. LIFE CYCLE - EGGS ARE LAID IN MANURE AND HATCH IN 24 HOURS; LARVAE PUPATE IN 5 TO 10 DAYS; FLIES EMERGE FROM PUPAE IN 3 TO 7 DAYS.

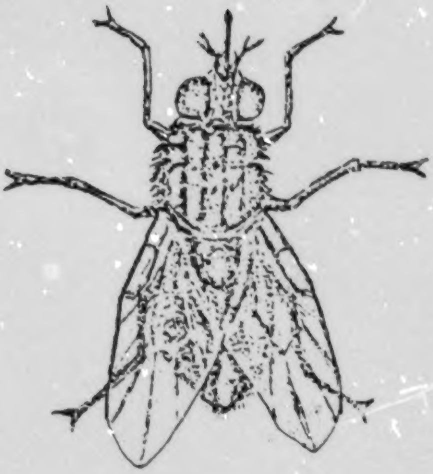
B. HOSTS - CATTLE

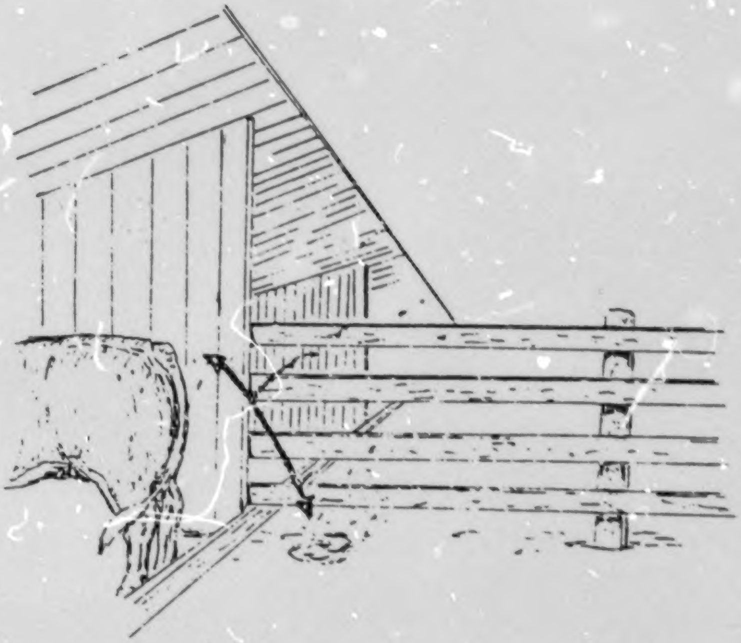
C. DAMAGE - 1. BITE AND SUCK BLOOD
2. TRANSMIT DISEASE

D. SYMPTOMS - 1. FLIES SWARM ON THE HEADS AND BACKS OF CATTLE

E. CONTROL - CHEMICAL PESTICIDES (DUSTS, SPRAYS, DIPS)

EXTERNAL PARASITES





FLIES - SEVERAL SPECIES

A. LIFE CYCLE - REPRODUCE IN MANURE, DEBRIS, AND DECAYING ORGANIC MATTER.

B. HOSTS - ALL CLASSES OF LIVESTOCK

C. DAMAGE - 1. BITE HOSTS
2. SUCK BLOOD
3. TRANSMIT DISEASE
4. CAUSE ANNOYANCE

D. SYMPTOMS - FLIES ARE VISIBLE, AND HEAVY INFESTATIONS ARE COMMON AROUND BARNS AND LOTS.

E. CONTROL - A. SANITATION
B. CHEMICAL PESTICIDES (SPRAYS, DIPS, AND DUSTS)

ANIMAL SCIENCE

Unit 2: Livestock and Poultry Diseases

Lesson 4: Internal Parasites of Livestock and Poultry
(2½ hours)

Terms: All terms underlined are in the "Glossary of Terms."

Internal parasites are those which affect the digestive respiratory, circulatory, and reproductive system or the internal organs of animals. In most cases, internal parasites are not visible, but their affect upon livestock is noticeable. A decrease in weight, lower gains, and death may result from the failure to control internal parasites.

Transparency No. 1

1. Roundworms (of the Digestive System)

   There are several species of livestock stomach worms. The most common and of greatest economic importance in Oregon are the twisted stomach worm, the brown stomach worm, and the threadworm or strongyles. There are several species of strongyles. Their normal habitat is the small intestine but are found in the abomasum of ruminants. Ascarids are another species of roundworm found almost exclusively in the small intestine. Ascarids are small, blood-sucking worms scarcely visible to the naked eye.

   Hosts - Roundworms attack all classes of livestock but are more commonly found in cattle, sheep, and horses.

   Life cycle - The roundworm in the adult stage lives as a blood-sucking parasite attached to the stomach or intestinal wall. The eggs pass from the animal in the feces. Depending on the temperature and humidity, the eggs will hatch in 5 to 20 days into larvae. The larvae crawl up a blade of grass, are eaten by an animal, travel to the stomach, and attach themselves to the stomach wall. The larvae can live for months on the ground before being eaten by the animal.

   Damage - Once the worm is in the intestine, the young worms burrow in and out of the stomach lining until they mature. This causes severe internal damage and reduces the digestion of nutrients. Poisons produced by the worms also have damaging effects. Young, undernourished or diseased animals are the hardest hit.

Symptoms - The most common symptom is anemia, which is shown in paleness of the mouth and eyes. The symptoms in severe infestation are persistent scouring, loss of weight, "bottle jaw", anemia, prostration, and death. In a light to moderate infestation, the animal will have a dull hair coat, scours, and will give an unthrifty appearance. Since these symptoms are associated with other parasites, the student will have difficulty recognizing an infected animal until it is severely infested.

Control measures - Sanitation and pasture rotation are the best control measures. In larger pastures and under range conditions, such as in Western Texas, roundworms are not as big a problem. When livestock are confined to small pastures or lots, roundworm control is important.

Chemical wormers are used to treat infested animals. Good worming programs are a necessity in controlling roundworms in all classes of livestock. Consult with local veterinarian for recommendations on chemical control.

Transparency No. 2

2. Lungworms

Lungworms are roundworms that affect the circulatory system and lungs. Their control is generally not considered as being of economic importance.

Hosts - All classes of livestock are affected by lungworms. Also dogs are affected in some areas.

Life cycle - The life cycle of lungworms is somewhat similar to other species of roundworms. The eggs are layed in the lungs, coughed up, and then swallowed. The eggs hatch in the stomach or intestine. The larvae are deposited in the feces. After a period of development in moist earth or water, roundworms are swallowed by the host and pass to the intestines where they burrow through the intestinal wall into the lymph nodes and are carried to the lungs. This completes their cycle.

Damage - In heavy infestations, a mechanical blockage of the lungs, causing a collapse of the infected area, furnishes an ideal location for other types of organisms to start an invasion. They may also be found in knots in the wind pipe and in the bronchea.

Symptoms - The first sign of this worm is a cough, which becomes more and more frequent. Breathing is faster and more forceful, and often a grunt follows each breath. As breathing becomes more difficult in severe and fatal cases, the animal breathes with its mouth open and tongue protruding. A foamy and sometimes a bloody material may collect around the muzzle. The animal is reluctant to move, usually has a fever, goes off feed and water, and become gaunt.

Control measures - There is not a good treatment for the lungworm; therefore, control is approached from a prevention standpoint. Good sanitation and pasture rotation practices are the best methods of prevention. Chemical control can be used with some success, if it becomes necessary. Consult with local veterinarian for recommendations on chemical control.

Transparency No. 3

3. Liver Fluke

The liver fluke is especially damaging to young animals. In some parts of Oregon, it is more difficult to raise sheep due to the fluke and other internal parasites, under pasture conditions.

Hosts - Sheep, cattle, goats, and man are the major hosts.

Life cycle - The adult lives in the bile ducts where the eggs are layed and pass down into the intestine. The eggs pass out of the animal's body in the feces. The eggs must be in water to hatch. The eggs hatch into small larvae which swim about seeking a snail in which to penetrate. The snail is a must for the fluke to complete its cycle. After a period of development in the snail, the larvae stage emerges and encysts on plants along the water. Livestock eat the water plants and become infested. The young flukes, found in the intestine, burrows through the abdominal cavity and into the liver where they live principally on blood. Egg production begins about 3 months after entering the animal.

Damage - The fluke causes irritation of the bile ducts, enlargement and thickening of the wall of the bile duct, and fribrosis of the liver tissue. Such livers are unfit for human consumption.

Symptoms - The usual symptoms are anemia and loss of weight. A heavily infested animal may die.

Control measures - Control of the snail is a means of controlling the fluke, but this is difficult. Pasture rotation and using water troughs instead of earthen tanks help control flukes. The use of hexachloraethane will kill the mature fluke. It should be administered twice a year to secure complete control. Consult with a local veterinarian for recommendations on chemical control.

Transparency No. 4

4. Tapeworm

There are several species of tapeworms. Three important species to the livestock producer are the broad tapeworm, beef tapeworm, and pork tapeworm.

Hosts - The broad tapeworm affects all classes of livestock. The beef tapeworm and pork tapeworm are principally parasites of cattle and swine. The adult stages of both species live in man.

Life cycle

a. Broad tapeworm - The adult lives in the small intestine. The adult reaches a length of 10 or more feet. Segments of the tapeworm, which contain eggs, are continuously breaking off and passing out in the feces. The eggs are eaten by the oribatid mite which lives in grass and weeds. The eggs develop in these mites and are eaten by livestock. The eggs then hatch in the small intestine and pass in the feces. This completes their life cycle.

b. Beef tapeworm - The adult lives in man. The eggs from these worms contaminate the feed of livestock. The eggs are eaten by cattle and hatch in their intestines. The young worms burrow into the muscle where they form a cyst. Completing the cycle, man eats the steaks containing the cysts.

c. Pork tapeworm - The cycle is the same as the beef tapeworm, except the larvae live in pork.

Damage - The tapeworm does little damage to the host, as they do not suck blood or eat tissue. However, they are in competition with the host for food.

Symptoms - Heavy hair coat, loss of weight, diarrhea, and emaciation are the main symptoms.

Control measures - Tapeworms can be removed from their hosts by administering certain medications. Consult with a local veterinarian for recommendations on chemical control.

Transparency No. 5

5. Horse Bot or Knit Fly

The horse bot, which is a parasite of horses only, is very closely related to the heel fly. There are at least three species. In the same manner as the heel fly, the bot fly lays eggs on the hairs of the horse's legs, belly, and throat region. Also like the heel fly, they terrorize the horse with the buzzing sound they make in flight. Having no stinger or mouth parts, the bot fly does not inflect any physical pain by biting or stinging.

Hosts - Horses are the only host of the bot fly.

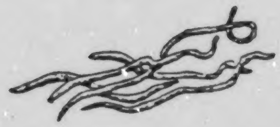
Life cycle - Bot flies emerge in the first warm days of spring. The female lays as many as 500 eggs on the hairs of the horse's body. The horse licks or bites itself where the eggs are attached, and this stimulates hatching. The newly hatched larvae enter the mouth and migrate through the body tissue to the stomach where they attach themselves to the stomach wall. They remain in the stomach until they reach maturity which is 5 to 8 months. At this time, the bots pass in the feces and pupate into adult flies. This completes the cycle. Bot flies are also seen in the late summer and early fall, which indicates that the cycle does not begin and end at any given season.

Damage - The larvae can become so heavily populated in the horse's stomach that the horse can digest and utilize only a small portion of its feed. The point of attachment in the stomach leaves an ulcer-type area. In severe infestations, the larvae can cause the stomach to rupture.

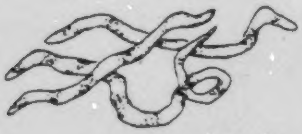
Symptoms - The adult bot fly is very evident in the spring and fall. The loss of weight, dull hair, a pot belly, low-feed conversion, and colic are symptoms of a bot infestation.

Control measures - The horse bot can be controlled only by worming. Worming is usually done about six weeks after the first killing frost in the fall and again in the late winter. Consult with a local veterinarian for recommendations on chemical control.

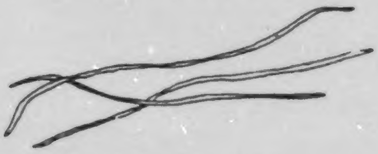
INTERNAL PARASITES



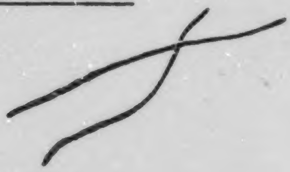
BROWN STOMACH WORM



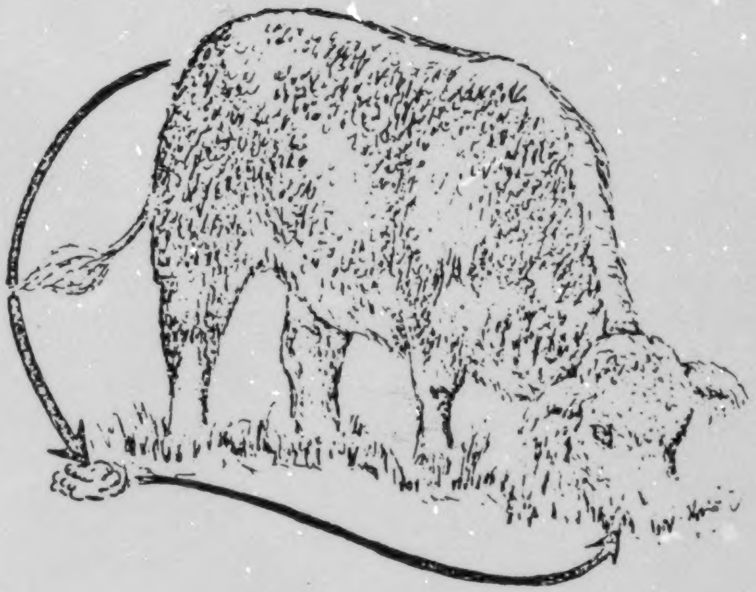
TWISTED STOMACH WORM



STRONGYLES



ASCARIDS



A. LIFE CYCLE - ADULTS ARE FOUND IN THE STOMACH OR SMALL INTESTINES; EGGS PASS OUT IN FECES, HATCH, AND ARE SWALLOWED BY LIVESTOCK.

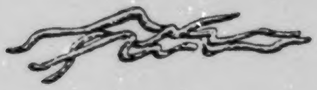
B. HOSTS - ALL LIVESTOCK

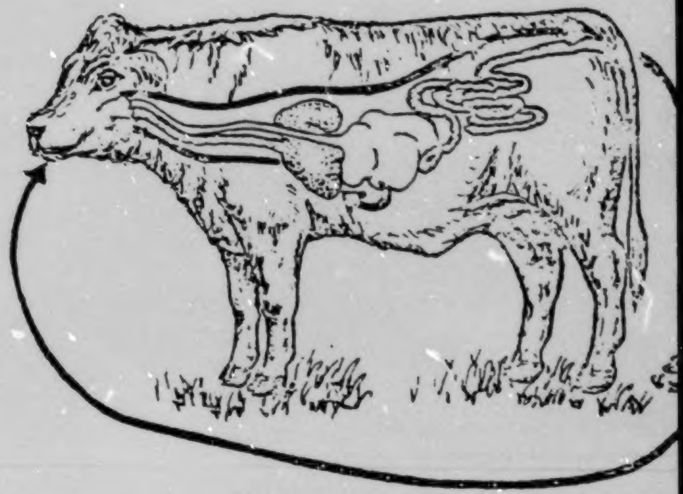
C. DAMAGE -
1. SUCK BLOOD
2. DAMAGE STOMACH LINING

D. SYMPTOMS -
1. ANEMIA
2. PROSTRATION
3. BOTTLE JAW
4. EMACIATION

E. CONTROL -
1. SANITATION AND PASTURE ROTATION
2. CHEMICALS

INTERNAL PARASITES





LUNG WORMS

A. **LIFE CYCLE** - EGGS ARE LAID IN LUNGS AND ARE COUGHED UP, AND SWALLOWED; WORMS HATCH IN THE DIGESTIVE TRACT, PASS IN FECES, AND ARE SWALLOWED BY LIVESTOCK; THEY BURROW THROUGH INTESTINE INTO LYMPH NODES AND ARE CARRIED TO THE LUNGS.

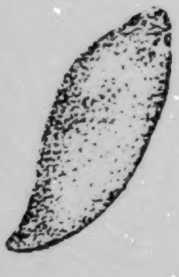
B. **HOSTS** - ALL LIVESTOCK

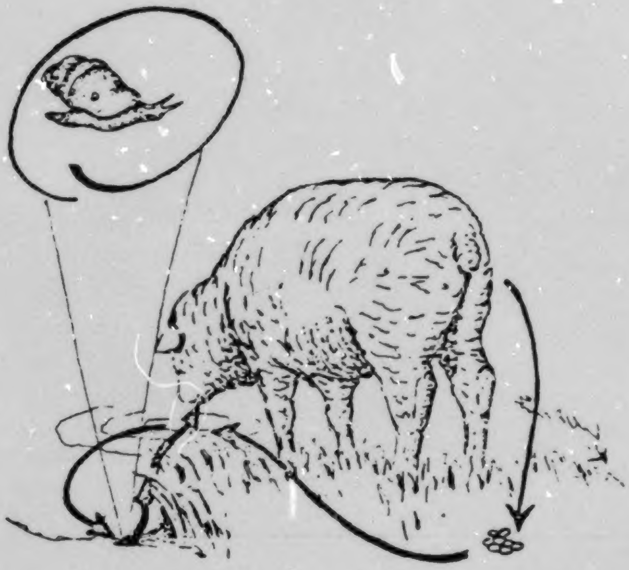
C. **DAMAGE** - 1. BLOCKAGE OF LUNGS

D. **SYMPTOMS** - 1. COUGH
2. FORCED BREATHING
3. BLOODY FOAM ABOUT THE MOUTH

E. **CONTROL** - 1. SANITATION
2. CHEMICAL TREATMENT

INTERNAL PARASITES





LIVER FLUKE

A. LIFE CYCLE - EGGS ARE LAID IN BILE DUCTS, PASS INTO INTESTINES AND ARE EXPELLED IN THE FECES: THEY HATCH AND PENETRATE A SNAIL. AFTER A PERIOD OF DEVELOPMENT, THE FLUKE EMERGES FROM THE SNAIL AND ENCYST ON PLANTS, WHICH ARE EATEN BY LIVESTOCK.

B. HOSTS - SHEEP, CATTLE, GOATS, AND PEOPLE

C. DAMAGE - 1. IRRITATION OF BILE DUCTS
2. THICKENING OF THE WALLS OF THE LIVER
3. RUIN LIVERS FOR HUMAN CONSUMPTION

D. SYMPTOMS - 1. ANEMIA
2. LOSS OF WEIGHT

E. CONTROL - 1. CONTROL OF SNAIL
2. PASTURE ROTATION
3. CHEMICALS

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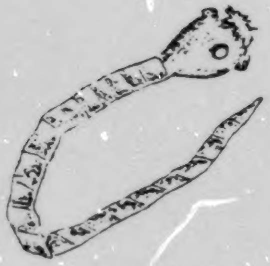
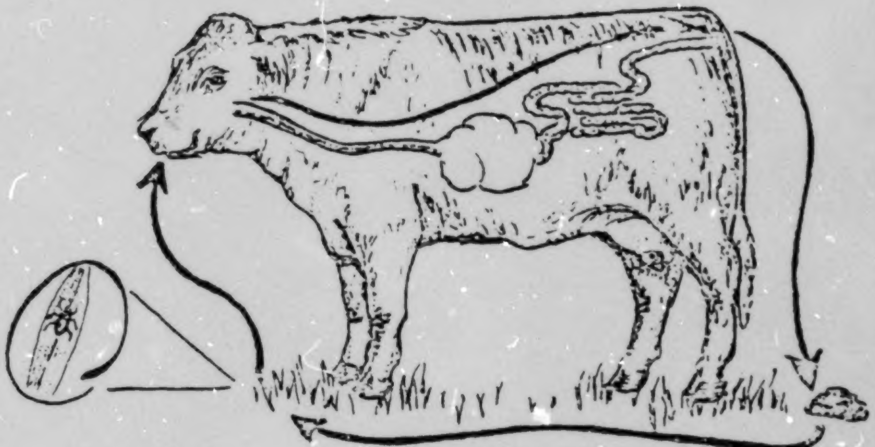
INTERNAL PARASITES





TAPEWORM

A. LIFE CYCLE -
1. BROAD TAPEWORM - ADULT LIVES IN INTESTINE: SEGMENTS CONTAINING EGGS ARE PASSED IN FECES AND ARE EATEN BY THE ORIBATID MITE, WHICH IS EATEN BY LIVESTOCK.
2. BEEF TAPEWORM - ADULT LIVES IN MAN; SEGMENTS OF EGGS CONTAMINATE LIVESTOCK FEED AND ARE EATEN BY LIVESTOCK AND HATCH IN THE INTESTINE; THEY PENETRATE INTO THE ANIMAL'S MUSCLES WHICH ARE EATEN BY MAN (STEAKS, ETC.).
3. PORK WORM - SAME AS BEEF ONLY IN PORK.

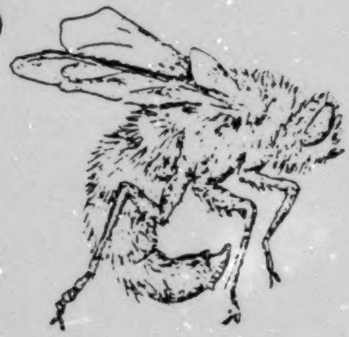
B. HOSTS - 1. BROAD TAPEWORM AFFECTS ALL LIVESTOCK
2. BEEF TAPEWORM - CATTLE
3. PORK TAPEWORM - SWINE

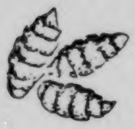
C. DAMAGE - 1. COMPETE WITH HOST FOR FOOD

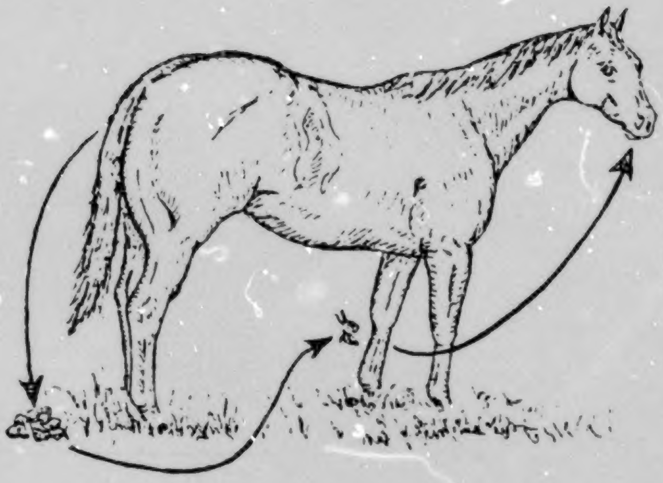
D. SYMPTOMS - 1. HEAVY HAIR COAT
2. LOSS OF WEIGHT
3. DIARRHEA

E. CONTROL - CHEMICALS

INTERNAL PARASITES







HORSE BOT - KNIT FLY

A. LIFE CYCLE - EGGS ARE LAID ON THE HAIR; THEY HATCH AND ARE SWALLOWED; THEY ATTACH THEMSELVES TO THE WALLS OF THE STOMACH AND ARE EXPELLED IN THE FECES IN 5 TO 8 MONTHS: THE LARVAE PUPATE INTO ADULT FLIES.

B. HOSTS - HORSES ONLY

C. DAMAGE -
1. LOSS OF WEIGHT
2. UNTHRIFTY
3. POOR FEED CONVERSION

D. SYMPTOMS -
1. ROUGH HAIR COAT
2. LOSS OF WEIGHT
3. COLIC

E. CONTROL - CHEMICALS

ANIMAL SCIENCE

Unit 2: Livestock and Poultry Diseases

Lesson 5: Prevention of Parasites (1 hour)

In the study of livestock and poultry parasites, as in the study of diseases, the student should remember the old adage, "An ounce of prevention is worth a pound of cure". Since different preventative measures are used, external and internal parasites will be treated separately.

1. Preventing External Parasites

The losses from external parasites or those parasites feeding, damaging, or living on the external parts of the animals can sometimes be reduced by good preventative practices. Some of the preventative measures are as follows:

a. Keep barnyards clean of manure to prevent fly breeding.

b. Scatter manure on pastures.

c. Have a regular spray schedule for livestock.

d. Spray barns, lots, poultry houses, swine feeding floors, and other livestock facilities to kill and control parasites.

e. Treat cattle with systemic insecticide to destroy grub larvae before they damage the hide.

f. Control brush and weeds in pasture that harbor ticks, horseflies, deerflies, mosquitoes, and other parasites.

g. Spray or drain, low wet areas to control parasites.

h. Spray all animals being moved on premises.

i. Check livestock and poultry frequently for presence of parasites or parasite damage.

2. Preventing Internal Parasites

Internal parasites are those that live in the digestive tract or other internal organs of an animal. These include such organisms as horse bots, strongyles, ascarids, tapeworms, and others. The following good management factors can be used in preventing the "build-ups" of internal parasites.

a. Stock pastures at moderate levels. Prevent close grazing.

b. Maintain animals in a good state of condition.

c. Rotate animals between pastures to improve grazing and prevent "build-up" of larvae population.

d. Observe animals regularly for signs of parasite problems.

e. Pen and treat animals showing signs of parasitic diseases immediately.

f. Keep feeders and waterers raised to prevent feed and water contamination by manure.

g. Keep barns and lots clean and dry. Practice good sanitation.

h. Keep animals in a healthy condition. Sick animals are easy prey for internal parasites.

i. Scatter manure on pastures.

j. Keep animals out of tanks or water troughs.

k. Dispose of manure so animals will not become contaminated by their own waste.

l. Drain or avoid moist, wet pasture sites.

m. Control flies and other intermediate hosts.

n. Graze colts, pigs, and other young animals on clean pastures.

o. Place pullets on clean range. Keep chickens and turkeys on separate ranges.

p. Keep clean litter in broiler and laying houses. Thoroughly clean and disinfect houses and equipment. Dropping pits or cages assist in controlling parasites.

Electricity

Instructor's Guide:

1. Read all information provided in this electricity unit before conducting any instruction.
2. Purchase all necessary tools needed for instructing the electricity unit.
3. Purchase all necessary materials needed for instructing the electricity unit.
4. Locate and order any audio-visual materials to aid in instruction.
5. Develop wiring boards so students may complete wiring of single pole, three-way and four-way light circuits.
6. Locate updated information from county.

Objectives:

Upon completion of this unit, students will be able to:

1. Know where electrical accidents occur.
2. Identify factors contributing to electrical hazards.
3. Explain causes of electrical hazards.
4. Describe when grounding is necessary.
5. Identify the purpose of a GFCI.
6. Use appropriate first aid for electrical accidents.
7. Control electrical fires safely and correctly.
8. Know how to identify electrical hazards.
9. Understand the fundamentals of electricity.
10. Plan for both safety and adequacy of electrical circuits.
11. Plan a wiring system.
12. Plan for an emergency power supply if one is needed.

13. Select wiring materials appropriate to the job at hand.
14. Knowledge of how electrical service gets to the farmstead.
15. Wire a service entrance.
16. Use correct wiring techniques in wiring receptacles, single switches, three-way switches and four-way switches.
17. Utilize various wiring devices correctly in wiring exercise.
18. Use electrical wiring tools and supplies correctly in wiring.
19. Perform maintenance operations on electrical motors.
20. Perform basic cleaning of electric motors.

Teaching Aids:

1. Electric Wiring Slide Sets

A.	Wiring a switch and lamp	$39.00	1983 price
B.	Wiring three and four-way switches	$42.25	1983 price

Hobar Publications
1234 Tiller Lane
St. Paul, MN 55112

Student Activities:

1. Understand the objectives of this unit.
2. Develop an electrical unit in Vo-Ag notebook.
3. Refer to Appendix A for a variety of student activities.

References:

1. VAS 3012a - Electrical Hazards in Home, Farm and Business
2. VAS 3003b - Planning for Electrical Wiring
3. VAS 3016a - Electrical Wiring Procedures

4. Electrical Wiring Exercises

   All above materials can be ordered from:

   Vocational Agriculture Service
   University of Illinois
   434 Mumford Hall
   Urbana, Illinois 61801

5. Basic Electricity and Practical Wiring

6. Basic Electricity and Practical Wiring - Instructor's Manual

   Above materials can be ordered from:

   Hobar Publications
   Division of Hobar Enterprises, Inc.
   1234 Tiller Lane
   St. Paul, MN 55112

7. Understanding Electricity and Electrical Terms

8. Electrical Wiring

9. Electric Motors

   Above materials can be ordered from:

   American Association for Vocational
   Instructional Materials
   Engineering Center
   Athens, GA 30602

Table of Appendices:

1. Appendix A: Electrical Wiring Exercises: Vocational Agriculture Services
2. Appendix B: Circuit Survey
3. Appendix C: Survey of Electrical Hazards
4. Appendix D: Graphic Electrical Symbols for Farm Wiring Plans

Terms and Definitions:

1. Electricity: a form of energy
2. Volts: the force or pressure of electricity
3. Amperes: the rate of flow of electricity
4. Resistance: that which opposes the flow of electricity
5. Volt meter: used to measure the electrical potential between two points in a circuit
6. Ammeters: used to measure the rate of flow of current in a circuit
7. Ohmmeters: instruments that have their own source of power and are used to measure resistance in ohms on disconnected electrical resistors
8. Watts: how electrical power is measured
9. Kilowatt-hour: kilowatt-hour is to electricity as horsepower is to an engine

ELECTRICITY

I. Electricity

A. Introduction

At one time, the only way to get work done was by human or animal labor. Only the rich could afford to hire the labor it would take to do the work electricity does for us today. Even the richest kings were not able to enjoy the wealth of comforts, convenience, and entertainment that electric energy brings us today. They could not enjoy central heating, air conditioning, motion pictures, television, and radio entertainment. They could not irrigate the large fields, dry their crops, or handle the harvest as efficiently as modern farmers do. Their markets and trading centers were not lighted, and agricultural commodities were not handled as our agricultural businesses operate today.

Electric energy is an important form of energy that serves American agriculture and agricultural businesses. Electricity is used for ourdoor lighting of feedlots, farmsteads, and agricultural and other businesses and is the primary source of indoor lighting in our homes. Electricity powers the labor saving appliances that enable a farmer to handle an enormous amount of grain without hiring additional manpower. Many farmers are unable to get a drink of water without the electric power to operate the water system. Electricity provides all of us with a wide range of entertainment appliances that add joy to our everyday living. It also provides an increasing amount of space heating in homes and farm buildings.

When properly used, electricity is one of the safest and most convenient forms of energy for light, heat, and power. When the rules for the safe use of electricity are broken, this safe and useful form of energy becomes a hazard to people and property.

Electrical hazards are primarily of two types: personal-injury hazards and fire hazards.

1. Personal-injury hazards are generally caused by burns, shocks, falls, and electrocution through contact with energized conductors, or defective equipment. Electric shock kills about 1100 Americans every year and injures about 5000 by accidental contact with electricity.

2. Fire hazards are caused by arcing, sparking, and overheating of conductors and equipment. Every week brings the announcement that someone, away from home for a short time, returned to find the home, barn, or farm equipment destroyed by a fire of electrical origin.

   Electrical hazards have become so notorious that often the origin of fires are incorrectly described as electrical. Fire investigators often assume the origin of a fire to be electrical simply because no other cause can be found. During the Bicentennial year, a fire marshall, faced with the problem of determining the origin of a fire in an historical wooden building, had to admit he was unable to determine its cause because the building had not been wired for electricity.

B. Where Do Electrical Accidents Occur?

1. Who were victims

Identity	Total No. of Accidents
Husband or employer	28
Wife	2
Son or male family member	37
Daughter or female member	8
Full-time employee	12
Part-time employee	10
Visitor	3

The son or male family member (not the head of the household) appears to be the person most frequently involved in electrical accidents.

Boys tend to outnumber girls about 9 to 1 as victims of electrical accidents.

2. Age of victims

Age	Total No. of Accidents
1- 9	9
10-19	33
20-29	10
30-39	4
40-49	6
50-59	7

Older children and youth seem to be the group most subject to electrical accidents. However, data for age groups other than the very young or very old are not published frequently. This could tend to bias the available data. On the other hand, we can assume that the inexperience of young people and their involvement in both recreation and work on the farm exposes them to electrical hazards quite frequently.

3. Activity of victims

Activity	Total No. of Accidents
Repair-servicing	24
Grain handling	20
Feed handling	16
Recreation	9
Water handling	6
Handling animals	3
Mowing	1
Unloading gravel	1
Well drilling	1
Climbing fence	1
Moving stacker	1
Pineapple harvesting	1

Repairing and servicing are the predominant activities at the time of electrical accidents, followed closely by grain handling activity. It is well to point out that very few, if any, of these accidents involved servicing of the electrical distribution system itself. Most cases involved working on machines, moving irrigation equipment, or installing television antennas. The total mortality for grain handling was boosted by two multiple fatality incidents in which several persons were moving portable auger conveyors or elevators when they contacted overhead power transmission wires. In one case, there were four fatalities plus one serious injury. In several cases, the elevators were being moved only short distances or were just being lowered from their working position when the lines were contacted.

4. Seriousness of injury

Seriousness	Total No. of Injuries
Fatal	84
Severe	14
Slight	7

Minor shocks are not reported, but all shocks may serve as a stimulus to correct the hazard in order to prevent yet another accident.

5. How injuries occur

Injury	Total No. of Injuries
Shock	4
Burn	15
Electrocution	82

There are two major ways in which people are seriously hurt when contacting electricity. The first is cardiac and respiratory arrest due to disturbance of the nervous system and the second is a physical burn caused by the current.

6. Causes of the accidents

Cause	Total No. of Accidents
Misuse of equipment	49
Worn equipment	12
Improper grounding	8
Improper installation	8
Improper equipment for job	5
Unguarded, uninsulated parts	4
Wind damage	3
Line fell	1
Trespass	1

Accident investigation generally recognizes the existence of the man, the machine, and the environment. Actions of the person involved can usually be listed as the cause of a majority of accidents. Where a cause could be determined in the above cases, over half were related to misuse of equipment or improper action of the operator of a piece of equipment.

7. Electrical equipment involved

Electrical Equipment	Total No. of Accidents
Power line	59
Wiring	10
Power tool	9
Radio and television	6
Electric fence	5
Water heater	3
Motor	3
Welder	1
Light socket	1
Fuse box	1
Steam cleaner	1
Transformer	1

The high incidence of power-line accidents is surprising. As can be seen, contact with an overhead power line was the predominant electrical agency involved. It should be noted that wiring figures in only 10 of the cases classified.

8. Farm equipment involved

Farm Equipment	Total No. of Accidents
Auger	15
Elevator	15
Irrigation equipment	10
Harvesting equipment	6
Fence (accidentally energized)	5
Electric Fence	5
Saber saw	3
Dairy truck	2
Power drill	1
Tractor	1
Trailer dump truck	1
Truck boom	1
Well digging	1

Not all classes involved mechanical things that could be classified as farm equipment. It should be noted, however, that the combination of augers and elevators heads the list. Irrigation equipment accounted for ten of the incidents. The upending of irrigation pipe or the contact of movable boom-type equipment with overhead power lines usually caused these accidents.

It may be noted that there are ten fence cases. They are categorized into fences accidentally energized, and incidents with electric fences. The accidentally energized fence cases involved storm damage or other misplaced primary or secondary power sources. The electric fence accidents all involved make-shift devices. No case has been reported in which a fence powered by a manufactured, UL approved electric fence controller has been responsible for a serious injury or fatality. Some unapproved units have been accused of causing property damage.

The two dairy truck cases involved retail delivery trucks loading at farm processing plants. In both cases, the body of the truck became energized by 120 volt (or 240 volt) power cords used to operate onboard refrigeration units.

9. Power source

Power	Total No. of Accidents
Hi-line	56
110 Volt	28
220 Volt	6
Lightning	2

Contact with the overhead power line is responsible for the greatest number of electrical accidents. Power lines are built according to the National Electrical Code and farm workers must be aware of this electrical hazard.

10. Location of accidents

Location	Total No. of Accidents
Barnyard	33
Field cropland	15
House	10
Front-backyard, garden	7
Open land (woods, pasture, etc.)	4
Grain storage	4
Barn	3
Dairy plant (on farm)	2
Machinery storage	2
Pond, pool, river	1
Road - township, country	1
Greenhouse	1
Hay storage	1

No accidents that occurred in farm homes were included in this survey. Several accidents and fatalities were caused by the erection of radio and television antennas.

11. Existing conditions

Condition	Total No. of Accidents
Wet	8
Dry	6
Good lighting	6
Muddy	6
Damp	4
Poor lighting	1
Snow-covered	1
Storm threatening	1
Windy	1

Few reports give clues as to the conditions at the scene of accidents. Common sense indicates that certain conditions are more conducive to electrical accidents than others, and that greater care should be taken when these conditions exist.

12. Work or play

Activity	Total No. of Accidents
At work	69
At leisure	26

Most of the adult accidents were work related, and most of the leisure related accidents involved children. A number of children in the 10 to 15 year old age group were occupied with work activities at the time of the accident. This is a factor to keep in mind when dealing with the farm-work environment.

Contact with overhead power distribution lines is the greatest cause of farm electrocutions at the present time. Be constantly aware of the ever present hazard of overhead power distribution lines, so that appropriate countermeasures can be taken. Proper installation and maintenance of electrical equipment are important to safety.

C. What Factors Contribute to Electrical Hazards

1. Not knowing hazard existed

This lack of knowledge may come from a lack of proper education on the job, lack of experience, or the inability of the person to recognize the hazardous condition. An example is a worker who uses a defective portable electrical tool in a wet area and does not know the tool is defective. The hazard can also arise because of a situation created by a fellow worker or from an unusual set of circumstances. Such hazards occur when someone energizes a circuit on which another person is working or equipment becomes energized due to failure of insulation.

2. Indifference

In this situation, the individual may know the safe method of work but may simply not care to use it. This attitude may be temporary or continuing. An example is a worker who is aware of the danger in the work situation, but is indifferent to it. We will not spend the time to take the necessary precautions because he feels he has more pressing problems to attend to. He may state, "Oh, why bother, nothing is likely to happen."

3. Daring

This kind of behavior actually blinds the individual to the hazards that are present. Behavior of this sort may be the result of clowning around or accepting a dare in order to get the approval of fellow workers. An example is a worker who accepts a dare to connect wiring while the current is turned on. These acts of "showing off" are sometimes introduced by boasting, "hey, man, watch me do it."

4. Poor work habits

Many workers develop poor or careless work habits from performing the same job day after day. Some of these work habits can be formed early on the job and others may be developed later, due to familiarity. This is often the case when an individual works at his job for many years and suddenly becomes an accident victim. He may have had poor work habits all along and the "law of averages" finally caught up with him.

There are many fatal accidents involving electricity by well-trained technicians who, because of overconfidence or carelessness, violate rules of personal safety. They develop the attitude, "I never get hurt."

The first rule of electrical safety should be "THINK SAFETY FIRST." Workmen should use the correct tools for the job and use them only for their intended purpose. A screwdriver is the correct tool for tightening screws, but it is a hazard when used to pry out cartridge fuses. The correct work procedure is to study the job at hand, think through all of the steps, and to determine the correct methods, the proper application of tools, and proper equipment to use.

Another good work habit is to try to avoid being distracted while working on electrical equipment. Failure of a worker to tighten a screw on a conductor can later cause arcing and start a fire.

5. Poor example

The new employee may follow the example of an older employee who has unsafe work practices and develop the same careless work habits. Safety is the responsibility of every person in an organization and every member of a family. It is an accepted fact that employees will pay attention to a subject in proportion to the emphasis placed on that subject by their supervisors. Younger children adopt the habits of older members of the family.

6. Laziness

Almost all persons are somewhat lazy. The degree of laziness that brings about careless work habits becomes critical in a hazardous situation. A worker may be too lazy to walk to the fuse box to open the circuit, but in a wet location, working around exposed wires or electric equipment, it is a serious hazard not to disconnect the power. This lazy attitude is often expressed, "Oh, it's too much trouble."

7. Haste

The desire to get work done in a hurry and forget safety can cause an injury. This situation frequently occurs as workers are trying to finish a job before dark, before a storm strikes, etc. It may also be caused by an unrealistic speed-up in production that is demanded by the job.

8. Temper

   This is sometimes called impatience or lack of emotional control which may lead to an unsafe act. A worker may be frustrated by something unrelated to the job (like a flat tire on the way to work) or react with careless, hazardous work on the job.

9. Physical failure and fatigue

   All individuals have physical limitations. The worker may be on a job that he cannot properly handle because of fatigue, poor eyesight, poor hearing, or mental and physical exhaustion.

10. Lack of training

    This can be the most glaring cause of electrical accidents. Lack of education is a handicap just as the physical handicap of poor eyesight or poor hearing. Periodic reviews of the proper use of electricity and correction of electrical hazards will help insure a proper education of all concerned.

11. Failure to follow the rules of the code

    The person installing electrical equipment may not recall the specific Code rules or may be unaware that the Code exists. This lack of information can cause violations of the Code and create electrical hazard conditions.

    Due to the technical information in the electrical Code, many persons can read the Code and still not understand it. If you are in doubt, ask your power supplier representative, an electrical inspector, or an electrician whom the power supplier may recommend to you. If in doubt, it is better to ask for advice than to decide to risk your own judgment. The National Electrical Code has a complete index and it is helpful to review the index when looking for the answer to a problem.

12. Failure to use approved materials

    Some people tend to look upon approved equipment carrying the name Underwriters Laboratories as being unnecessarily expensive and not worth the added cost. In some cases, they may be able to buy unapproved equipment at a lower price. However, inferior equipment is usually more costly in the long run.

The UL label is the best evidence that can be presented to show that an electrical product has been manufactured and tested to meet acceptable standards of safe performance. The UL label is one of the most widely known and respected symbols of dependability in electrical equipment. The UL label in effect says to the buyer, "You can depend on this product" when it is properly installed and maintained.

The primary purpose of the Underwriters Laboratories is to test and approve samples of electrical appliances, cords, power tools, and so forth, to assure you that they are electrically safe. The UL label means that one or more samples have been submitted by the manufacturer to Underwirters Laboratories for testing. If an item proves to be safe, the Laboratories list the item and authorize the manufacturer to put the UL label on all production items of the same model. This does not in any way guarantee that the appliance or the equipment which you purchased will remain safe for its entire life. It is your responsibility to see that it is properly maintained and safety checked periodically.

The UL label on an electrical cord which you buy means that the cord is approved only for certain specified purposes. For example, a type SP-1 rubber cord means that it is safe to use on a floor lamp or a table lamp. It does not mean that it is safe for use on an iron, toaster, or electric soldering iron. For these purposes, a type HPD cord should be used. Many people have been fooled into buying unsafe appliances because the UL label appeared on the cord. Some manufacturers purposely use a UL approved cord on an appliance which does not itself have UL approval. Thus, be sure to check for a UL label both on the cord and on the appliance itself.

Homemade appliances. It is possible to buy UL approved cords, sockets, switches, and other components. These can, then, be assembled into homemade appliances, such as darkroom equipment, plant propagation beds, air compressors, etc. Although each part is approved, the finished assembly will not be, for the method of assembling them has not been checked for safety. A dangerous mistake may be made in assembling the appliance that could cause a shock, fire, or electrocution although it may work perfectly.

Do not buy cheap, unlabeled products to save money. Watch for ratings of appliances and equipment in consumer products magazines, ask the advice of your electrician and buy only from reputable dealers whose judgement and products you respect.

13. Failure to have wiring installations checked by a qualified person

    Your power supplier representative or electrical inspector will be glad to advise you of correct procedures to follow when wiring or rewiring. They will come and inspect your home, farm, or business and give you their recommendations on the wiring. They will often have suggestions that not only increase safety but also save money.

14. Poor workmanship

    A person may know how to do a job correctly, but he may decide to use a shortcut, such as omitting junction-box covers, cable connectors, etc.

15. Failure to inform the family of emergency procedures in the event of trouble

    When dealing with electricity and its countless potential hazards, the members of the family should be dependent upon one another. Be sure you have a home evacuation plan in case of fire and a specific procedure to follow in case of emergencies.

D. What Are Specific Causes of Electrical Hazards?

1. Electrical energy should not be feared, but it must be respected. To fully understand electrical hazards, it will be helpful to review a few electrical terms.

    a. Voltage is a term applied to the force used to push electric current over a conductor. The greater the voltage, the greater the amount of current available. Many farms and homes have 120/240 volt power. Ordinarily, small appliances and lamp bulbs operate on a lower-voltage or 120 volts. Larger appliances, such as air conditioners, clothes dryers, welders, etc., operate on higher-voltage of 240 volts. The use of "lower-voltage" and "higher-voltage" have led to the mistaken idea that lower-voltage of 120 volts is comparatively safe and that there is very little danger from a shock from these circuits. If help is available at the scene, the chances for survival are better if the shock comes from a high voltage power line. Deaths have occurred due to contact with 120 volt circuits using 1/10 ampere. Three-phase power is used in industry and on larger farms and provides 120/240 or 120/208 volts depending on the system. For additional information on three-phase power, see VAS 3038, "Using Three-Phase Electrical Power on the Farm."

b. Amperage is the term used to describe the flow of current moving over the conductors. The current lights the bulb, heats the toaster, and it is the current that kills!

Electrical power is measured in watts. This is what you pay for when you pay your electric bill. It is the electric power that actually does the work.

c. Resistance is the property that affects the flow of electrons in a circuit. For a given voltage, the higher the resistance, the smaller the current flow. Electrical resistance is measured in ohms.

2. To match the size of the conductors to the load, you will need to use some arithmetic and apply Ohm's Law. It states, VOLTS equals AMPERES times RESISTANCE ($E = I \times R$). E stands for Volts, I for Amperes and R for Resistance (ohms). It may be written in these other ways: AMPERES equals VOLTS divided by OHMS ($I = E/R$); or OHMS equals VOLTS divided by AMPERES ($R = E/I$).

   a. Since most appliances are rated in watts and volts we need another formula to find out how many amperes are used: WATTS (power) equals VOLTS times AMPERES ($W = E \times I$). Remember it is the amperes with which we are generally concerned when selecting the proper size of conductors.

   b. Probably the two items in the National Electrical Code that are most basic, and most vital to electrical safety are the ampacity of the conductors and matching them to the proper size of over-current devices.

3. The following are some specific causes of electrical hazards and should guide you in reviewing the electrical system in your home, farm, and business.

a. Worn-out in use

Electrical materials and equipment that have become worn out or deteriorated through years of use cause electrical hazards.

An electric hot plate is an example of an electrical appliance that may deteriorate due to a faulty cord connection, defective switch, or cracked porcelain insulator and cause the frame to become energized. Generally, some simple repairs can correct these hazards.

b. Lack of maintenance

We often neglect to maintain electrical equipment and appliances until trouble appears. We do, however, change the oil in an engine at regular intervals and we check the fluid level in the transmission, differential, and hydraulic units periodically even though there is no visible indication that they should be serviced.

We should make the same periodic inspections and follow a similar systematic maintenance program on electrical equipment and appliances as we do on automobiles and tractors. Usually the manufacturer provides recommendations for maintenance in the service manual that accompanies the appliance when it is sold. Salespersons tend to deemphasize the need for maintenance when they describe the operation of appliances and equipment because this may make a customer hesitate to purchase the equipment. The customer, however, should consider ease of maintenance when he selects a product.

Many electrical appliances require service of a nonelectric nature. If neglected, these can cause the equipment to fail. Clothes dryers, for example, need to be cleaned periodically to remove the accumulated lint to prevent a fire hazard as well as to permit better air circulation. Air conditioners often become so laden with dust that the air flow is restricted, which causes the unit to be over-worked and the increased current draw to overload the circuit.

A layer of dust acts like a blanket of insulation on a motor. It confines the heat until the motor may reach temperatures that are dangerous to the insulation. Dust also contains abrasives that increase wear on bearings, shafts, and commutators. Dust absorbs oil, moisture, and acid fumes that cause insulation to deteriorate quickly. Vo-Ag Service Slidefilm No. 416a, "Cleaning Electric Motors," illustrates these problems in detail (this is available from Vocational Agricutlture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Some electric motors need to be lubricated to insure their long life. Motors lacking lubrication may overheat, the bearings will seize, and the motor will start to burn. Slidefilm No. 417a, "Practical Maintenance of Electric Motors," illustrates these problems (this is available from Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

c. Conductors

1) Worn-out insulation

Common sense tells us to replace a conductor when its insulation has fallen off, leaving it bare or exposed.

Before replacing a conductor, however, determine if the deterioration was from normal wear or from some fault that could have been prevented, such as excessive heat or current overload.

Refer to the tables in the National Electrical Code under Article 310--Conductors for General Wiring, to be sure that the replacement conductors are correct for the application. Table 310-13 lists the application for the conductor and the type of insulation. For example, the new THHN heat-resistant thermoplastic wire has an insulation that is flame retardant, heat resistant, and covered with a nylon jacket. The maximum ampacities for copper, aluminum, and copper clad aluminum conductors are given in Tables 310-16 and 310-19.

2) Aluminum conductors

Aluminum conductors are widely used as service drop conductors. Some contractors and builders are using NM cable with aluminum or copper-clad aluminum conductors. The Code rating for copper-clad conductors is the same as for aluminum: No. 12--15 amps., No. 10--25 amps. The copper-clad aluminum is approved for use with UL listed wiring devices of the "push-in" type.

Some failures of receptacles wired with aluminum wire have been caused by using back wired receptables (push-in type), or by failing to tighten the binding screws securely. In some instances of failure the aluminum was not compatible with the metal terminals and corrosion or arcing occurred. Vibration, temperature changes, and humidity have also been responsible for some failures in aluminum wiring.

In order to avoid these problems, the Aluminum Association (Aluminum Building Wire Installation Manual and Design Guide) recommends these practices. Use only receptacles marked with CO/ALR label. This means that the devices have been tested to withstand a severe overload to determine their suitability. Underwriters Laboratories state that the following types of devices may be used with UL labeled copper or copper clad aluminum conductors but shall NOT be directly connected to aluminum conductors:

a) Receptacles and snap switches marked "AL-CU."

b) Receptacles and snap switches having no conductor marking.

c) Receptacles and snap switches having back wired terminals or screwless terminals of the push-in type.

Give special attention to attaching aluminum conductors to binding screws. (1) Wrap the stripped end of the wire 2/3 to 3/4 of the distance around the post of the wire-binding screw. (2) Tighten the screw until the wire is snugly in contact with the underside of the screw head and the contact plate marked CO/ALR.

(3) Tighten the screw an additional 1/2 turn. This insures a firm connection. If a torque screwdriver is used, tighten to 12 pound-inches. (4) Position the wires so as to decrease the likelihood of loosening terminal screws when mounting the device to the outlet box.

3) Worn-out flexible cords

The wear on flexible cords can often be traced to their misuse which includes running flexible cords through doors, under rugs, wrapping around nails for support, or using the wrong type of cord for the location.

Some appliances give trouble free service for 20 years or more and in that time the insulation on wires or electrical cords may deteriorate due to heat, oil, or age and cause electrical hazards.

Article 250-45. Equipment Connected by Cord and Plug, requires grounding of practically all major appliances and portable tools used in both residences and nonresidential structures. When replacing cords on power tools and appliances, 3-conductor cords of proper size should be used and approved attachment plugs (Article 410-56) should be installed on the cords.

One city electrical inspector claims that old cords on lamps and clocks are responsible for more electrical fires in homes than any other single cause. As the housewife moves the lamp or dusts around the clock cord, the insulation cracks and the conductors break, until the electrical load is carried by only a few strands of the conductor. These fine wires overheat, melt and start a fire in the rug below the clock or lamp. In these instances, age and usage combine to create an electrical hazard.

Consult tables in Article 400--Flexible Cords and Cables for correct cords to use as replacements for defective ones. Table 400-4 lists trade names of various cords and tells where these cords can be used. For example, lamp cord shall be used in dry places and is not designed for hard usage, while Type "SO" hard service cord has an outer coating of oil resisting compound and is designed for extra hard usage.

If flexible cords are used to extend circuits (another receptacle is needed) the hazard should be corrected by adding circuits or a circuit extension (additional receptacles).

Other important Sections of Article 400 are as follows: 400-7. Uses Permitted; 400-8. Uses Not Permitted; 400-9. Splices; 400-10. Pull at Joints and Terminals.

Section 400-23. Grounding-Conductor Identification, states that conductors having a continuous green or green with one or more yellow stripes must be used for grounding purposes.

Three conductor cords were introduced into general use because many deaths were caused by faults in appliances, such as electric washing machines and portable power tools. The black and white conductors carry the current that operates the appliance and the green conductor is attached to the metal frame.

4) Attachment plugs

Section 410-56(d), Attachment Plugs, requires all 15- and 20-ampere attachment plugs and connectors be so constructed that there are no exposed current-carrying parts except the prongs. This requirement is intended to eliminate the "open face" front-wired attachment plug having the wire-binding screws protected by a readily removable cover usually made of insulating paper. These covers are easily dislodged and since the connections are frequently poorly installed, this regulation has been put into effect. The simple fact that the devices are usable without covers has often resulted in the use of bare-faced plugs. This is a hazardous practice for two reasons:

a) It is a shock hazard
b) An electric arc may be struck due to stray conductor strands protruding from the open face that may be energized.

Molded attachment plugs are factory attached to the cords and are usually a part of the cord set or the appliance and are not generally available for sale to the general public. There are, however, several types of side- or back-connected, solid front, nonmolded attachment plugs available at electric supply stores that meet the new Code provisions.

d. Overcurrent protection

The question is often raised about the advantages and limitations of fuses and circuit breakers and their purpose in the electrical system.

1) Both of these devices are used for three reasons

    a) To protect a circuit from damage due to overload
    b) To protect a circuit from damage due to a short circuit
    c) To interrupt as small a part of the electrical system as possible. The device should limit the electrical outage to the area affected

2) The advantages of fuses include the following

    a) There are no moving parts to corrode and malfunction
    b) They are generally faster. The time required to open the circuit is generally less than other devices.
    c) They are reliable. A given cross section of metal will melt at a given temperature. They do not fail to open.

3) Their limitations include the following:

    a) A fuse can be replaced with one of a larger size that carries more current than should be carried by the conductors.
    b) Fuses can (and often are) replaced by nonfusible metal links that remove all overcurrent protection from the circuit.

e. Improper use of approved equipment

Equipment may comply with the safety standards of recognized testing laboratories, such as Underwriters Laboratories, but it may create a hazard when used under conditions not covered by its approval. Some examples follow:

1) Light bulbs

A common hazard in agricultural applications is mounting light bulbs in a horizontal position. Bulbs will dissipate heat up into a (porcelain) socket if mounted with the base up. However, if the bulb is mounted horizontally, heat rises to the upper surface of the bulb and if dust accumulates on the surface the temperature can get high enough to cause the accumulated dust to ignite.

2) Fuses

Fuses are of two kinds, cartridge and plug. The cartridge fuse consists of an insulating tube with metallic ends that fit into a pair of spring clips. The plug fuse has a base like a lamp bulb and screws into a socket. Both kinds contain a fusible metal link to conduct current.

An approved fuse may be used to protect a circuit, but if its rating is too large for the conductors (wires) it is protecting, or if it is the improper type specified for the equipment, a serious hazard can occur. For example, a 30-ampere fuse, used in a curcuit with No. 14 wire, could carry more current than the wire, and therefore the circuit can be overloaded. An overloaded wire will heat up and might start a fire. Replace fuses only with one of the proper size for the load, but in no case larger than permitted for the conductor. Always keep a supply of extra fuses of the proper size available. In some cases the load requirement may be smaller than the maximum load for the conductor, then the fuse should be as small as possible to protect the equipment. A combination fuse holder and receptacle may be used to provide this type of protection. A time-delay fuse can have a smaller rating and still start the motor-powered equipment while providing protection to both the conductor and the equipment.

Article 240--Overcurrent Protection includes many important sections: 240-2. Protection of Equipment; 240-4. Protection of Fixture Wires and Cords; 240-21. Location in Circuit; 240-22. Grounded Conductors; 240-24. Location in or on Premises.

The practice of replacing fuses with coins or metal slugs is an invitation to a disastrous fire that can destroy lives and property.

3) Circuit breakers

Circuit breakers are more modern devices to protect electrical circuits. They trip when the circuit is overloaded or when a short circuit occurs. The power may be restored by resetting the breaker.

4) Conductor size

Conductors vary in size from small to very large and, naturally, the greater the load requirement the larger the wire. Conductors that are too small for the load cause first, a voltage drop which gives inefficient use of equipment or burns out the equipment; second, an increase in power consumption or power costs; and third, conductors must be large enough to stand stresses of wind and weight between supports, as well as the current requirement (Article 310--Conductors for General Wiring; Section 310-5. Ampacity). Additional tables in this section give current carrying ampacities for both copper and aluminum conductors.

5) Conductor type

Just as there are proper sizes of conductors for every electrical requirement, there are also proper types for every need. Normally, type refers to the insulation, however, there are different kinds of wire. The insulation on indoor-type wire, even though approved, could not be used underground. There is a special covering approved for this use. It is safer and more economical in the long run to comply with Code requirements. Article 310--Conductors for General Wiring, Section 310-5, Minimum Size of Conductors; 310-6. Underground Conductors; 310-7. Wet Locations; 310-8. Corrosive Conditions; Article 334--Metal-Clad Cable; Article 338--Service-Entrance Cable; Article 339--Underground Feeder and Branch-Circuit; Article 345--Intermediate Metal Conduit; Article 346--Rigid Metal Conduit; Article 347--Rigid Nonmetallic Conduit; Article 348--Electrical Metallic Tubing; Article 349--Flexible Metallic Tubing; Article 350--Flexible Metal Conduit; Article 351--Liquidtight Flexible Metal Conduit; Article 352--Surface Raceways.

6) Overloading of motors and equipment

Unattended motors and equipment without protective devices can become overloaded, causing heating and short circuits, or possibly fire. Also, any overloading can increase operating expenses, and may lead to costly repairs or replacing of equipment. Delay-type fuses and thermal-overload protection devices can prevent such hazards (Article 430--Motors, Motor Circuits and Controllers, Section 430-14. Location of Motors; Sections 430-16. Exposure to Dust Accumulations, 430-31. General; 430-72. Overcurrent Protection).

f) Accidental occurrence

Hazards are generally created by lack of knowledge, indifference, forgetfulness, or failure to accept a hazard as a potential danger.

About 80 percent of fires and injuries in one state were caused by unsafe practices. About the only method of reducing this problem is by education. People must constantly be reminded of the danger, so they will be alert and watchful for these conditions. Examples of unsafe practices are:

1) Leaving combustible materials near or in contact with lamps
2) Leaving appliances turned "on" unintentionally
3) Dropping materials into electrical equipment accidentally
4) Leaving electrical equipment plugged in and within reach of small children

5) Contacting overhead wires with metal machinery
6) Using portable tools in wet or damp locations without proper grounding

In recent years there has been much emphasis on GFCI's (Ground Fault Circuit Interrupters). These have been recommended to protect people from shock injuries caused by accidental contact with live conductors while parts of their bodies are in contact with ground. Section 5 explains these devices.

g. Emergency power supply

Continuous power is essential on most farms and businesses and a power failure can have serious consequences. Poultry and livestock in total confinement buildings with electric ventilating equipment require continuous electrical service. Another example is greenhouse operations, where the heating, cooling, ventilating, and lighting system depends upon electrical equipment. On large dairy farms, where water cannot be pumped by hand and additional labor is not available for hand milking, continuous electrical service is required.

Power failures occur from storms, accidents, and equipment falling on the lines to cause service interruptions. With major natural disasters, such as tornadoes, blizzards, floods, and ice storms, power outages can last from several hours to over a month. In the event of power failure, every home and every farm is affected in varying degrees.

Since power failures do occur, standby equipment may be needed to provide electricity in an emergency. With standby electric service, a farmer or businessman can keep his power equipment operating during the power outages and avoid both inconvenience and possible financial loss.

Standby equipment must be connected to the wiring system by means of a double-throw switch which will disconnect the power supplier's service before the generator is connected. There are two important reasons for this requirement. First, this will prevent feeding power back into the supplier's line, thus endangering the lives of electrical linemen. Secondly, it prevents damage to the generator by feeding power back into it when normal electrical service is restored. Standby generating equipment is of two general types, engine-driven and tractor-driven units.

h. Mechanical execution and installation

The National Electrical Code Section 110-12. Mechanical Execution of Work, states, "Electrical equipment shall be installed in a neat and workmanlike manner." This ruling includes tightening screws, placing covers on boxes, proper mounting of cable, conduit, etc. This requirement is necessary for safety and appearance as well as making it easier for subsequent electrical repairs, maintenance, or additional extension of present service. When electrical equipment is installed without following the Code recommendations, it can only lead to an unsatisfactory installation.

1) Location of equipment in hazardous areas

By preplanning and laying out an installation, it is often possible to locate electrical equipment in less hazardous areas to reduce the need for special equipment. Where it is necessary to place equipment in a hazardous location, it is also necessary to use approved equipment for the specific location. Some hazards related to locations are:

a) Gasoline, liquified petroleum, and other flammable liquids should not be stored or used near unapproved electrical equipment. An ordinary switch, or an open-type motor, may spark causing an explosion and fire. Of course, this will only happen when the mixture of gas vapor and air is in the proper proportion for combustion.

There is no practical way for determining this condition, and it is therefore necessary to use equipment designed and recommended for such locations to be safe (Article 500--Hazardous (Classified) Locations; Section 500-3. Specific Occupancies; Article 501--Class I Locations).

b) A serious hazard exists where exposed light bulbs, open motors, and other open electrical equipment are found in dusty areas. Sparks from a motor, a flash from a broken light bulb or even heat from a bulb can ignite dust and cause a fire and, in many cases, an explosion. This problem occurs frequently in feed handling businesses and in grain elevators. Bulbs must be protected with a glass enclosure to keep dust or other combustible material from settling directly on them. This protection also helps to prevent breakage. Only dust proof motors should be used in a dusty area, such as the haymow or grain storage facilities on farms (Article 410--Lighting Fixtures, Lampholder, Lamps, Receptacles and Rosettes; Section 410-5. Fixtures Near Combustible Materials; 410-6. Fixtures Over Combustible Material; Article 500--Hazardous (Classified) Locations; Section 500-5. Class II Locations; Section 500-6. Class III Locations; Article 502--Class II Locations; Sections 502-4. Wiring Methods; 502-6. Switches, Circuitbreakers, Motor Controllers & Fuses; 502-11. Lighting Fixtures; Article 503--Class III Locations).

c) Boxes and fittings in damp or wet locations should be moisture-proof to prevent moisture from entering and accumulating within them. Buildings for the confinement of livestock and poultry, milking parlors, and greenhouses are examples of wet locations and should have equipment properly installed. The damger is not only from fires caused by electrical short circuits, but the danger of shock or electrocution to humans and animals is even more important. Another problem is suffocation of animals and poultry when service is interrupted.

If the service entrance cabinet is attached directly to the inside surface of the wall, moisture will collect on the cabinet and entrance conduit because of the difference in temperature between these metal parts and the inside of the building. The moisture will collect and may shut off all electric power to the building. To prevent this, place the service equipment in a weather-tight enclosure. Run all circuits through the bottom of the box to prevent moisture from collecting on the conductors and running down into the breakers or fuse equipment. Space the service entrance equipment so there is a one inch air space between the service equipment and the building wall. Be sure all junction boxes, outlet boxes, and fixture boxes are dust and moisture tight. Molded plastic boxes are available with drilled and tapped openings to prevent the entrance of moisture and reduce the shock hazard. (Article 300--Wiring Methods, Section 300-6. Protection Against Corrosion; Article 345--Intermediate Metal Conduit, Section 345-5. Wet Locations; Article 346--Rigid Metal Conduit, Section 346-4. Wet Locations; Article 347--Rigid Nonmetallic Conduit, Section 347-2. Uses Permitted; Article 370--Outlet, Switch and Junction Boxes, and Fitting, Section 370-5. Damp or Wet Locations; Article 380--Switches, Section 380-4. Wet Locations; Article 410--Lighting Fixtures, Lampholders, Lamps, Receptacles and Rosettes, Section 410-4. Fixtures in Specific Locations (a) Wet and Damp Locations, (b) Corrosive Locations.)

2) Wires entering buildings

Conductors entering through holes in a building without proper protection to the insulation will cause trouble. Normal vibration from wind will cause the conductors to rub against the building, and eventually wear through the insulation, causing a short circuit and possibly a fire. The use of drip loops, and an approved weather head is required (Article 230--Services, Section 230-59. Protection of Open Conductors and Cables Against Damage--Above Ground, Section 230-51. Mounting Supports Section 230-52. Individual Conductors Entering Buildings or Other Structures).

3) Connection and splices

Connect all conductors to terminals so they have the best means of contact. Some electrical contractors constantly check on the tightness of the connections made by their workmen because they know that loose connections cause arcing, heating, and interruptions in service. A poor splice in an electrical conductor is similar to a weak link in a chain. The entire installation may suffer. The splice can break, short out, or cause voltage drop. Splices must be enclosed in a box that will confine the fire in case there is arcing or sparking at the connection. The splices and ends of conductors must be covered with insulation equivalent to that on the conductor itself. A poor splice or connection is usually made because of carelessness or from lack of appreciation for the reasons for an approved method of joining conductors. (Article 110--Requirements for Electrical Installationa, Section 110-14. Electrical Connection; Article 410--Lighting Fixtures, Section 410-30. Connections, Splices and Taps.)

4) Boxes

Metal boxes for service entrances, switches, splices, or connections are not always used as required because the need for proper application is not understood. Actually, the purpose of a box is to house splices and connections, and guard live parts. When an electric circuit that is carrying current is interrupted, an arc is produced. This occurs whether the interruption is intentional or accidental. The intensity of the arc depends on the current and the voltage of the circuit. The temperature of an electric arc is very high and any combustible material in the vicinity may be ignited by heat. When a box is provided, spark or fire will be confined inside the box. At the same time, combustible building materials are not exposed to the fire. (Article 110--Requirements for Electrical Installations, Section 110-17. Guarding of Live Parts, Section 110-18. Arcing Parts; Article 300--Wiring Methods--General Requirements, Section 300-15. Boxes or Fittings--Where Required; Article 370--Outlet, Switch, and Junction Boxes and Fittings, Section 370-7. Conductors Entering Boxes or Fittings).

5) Workmanship

Connectors and staples are often omitted when wiring with nonmetallic sheathed cable because they are thought to be unnecessary. Without them, insulation on conductors can be worn through by normal vibrations within any building. This can cause short circuits. Many homes and farm buildings have burned because of failure to use such small and seemingly insignificant items (Article 200--Wiring Methods--General Requirements).

If knockouts are removed and then not used, they need to be closed to prevent fires and to keep rodents from entering the box (Article 370-8--Unused Openings).

6) Unapproved materials

Inferior materials are occasionally used for economy reasons. However, to save a few cents now is not accomplishing this goal in the long run. For instance, a glass heat lamp is lower priced, but will break much more easily than a Pyrex heat lamp. If one considers that electrical wiring and supplies like lampholders, receptacles, switches, etc., should be expected to last approximately twenty years, the higher quality items will usually be the most economical. Always buy materials approved by a recognized testing laboratory (Article 90--Introduction, Section 90-6. Examiniation of Equipment for Safety).

i. Home Hazards

Electrical safety in the home is based on the permanent wiring. No home can be free from electrical hazards while the original wiring and extensions or modifications are improperly installed. It is important that the wiring be adequate to carry the maximum current that may be required to supply all of the appliances without overheating the conductors. There should be a sufficient number of receptacles to provide for the convenient attachment of many portable electrical appliances. The portable lamps and appliances should always be plugged into receptacles and not into lighting fixtures. Circuits in the home wired with No. 14 wire should be protected with 15-ampere fuses or circuit breakers although circuits supply receptacles in kitchens and laundries are usually wired with No. 12 wire which should be protected with 20-ampere fuses or circuit breakers. When a fuse blows or a circuit breaker trips, the cause should be located and removed.

Since small children cannot read and do not understand how dangerous electricity can be, they are particularly vulnerable to electrical hazards. Several instances have been reported in which small children have had their faces disfigured by chewing on lamp cords plugged into receptacles.

j. Quality of Device

Most of the common electrical devices are available in three grades. Manufacturers refer to these as standard, specification, and hospital grades. While UL has specified minimum requirements for standard and hospital grades, most manufacturers design specification grade equipment to last longer than standard and include special features, such as lighted toggles in switches, back wiring features in receptacles, etc. Some specification grade equipment is guaranteed for 20 years. These devices cost more originally than standard grade but may prove to be more economical in the long run.

k. Electrical Extension Cords

Many times persons using portable electrical equipment are working in positions where they are perfectly grounded. Thus, a defective tool is a serious hazard. The defective tool may be laid on the floor of the tank, causing the entire tank to be charged. In one case, an entire farm grain handling system was charged by a defective power tool.

A portable tool or light is not grounded if an extension cord without a grounding conductor is used. To be on the safe side, replace all 2-conductor extension cords with 3-conductor grounding-type cords unless all portable tools are double insulated and need no grounding wire.

Extension cords not in use should be coiled and stored in a safe place. Preferably, this should be on a peg or in a drawer where heavy objects cannot be thrown against them. They should be kept unsnarled and should not be used when the covering is worn, frayed, or broken.

The cords on portable tools are subject to wear and abrasion. Regular inspection and maintenance are necessary to keep the cords in good, safe condition.

A safe, portable trouble light includes a socket covered with nonconducting materials. The lamp should be protected with a sturdy wire cage or guard, to prevent breakage. This guard, if made of metal, should be grounded just as for any other portable device.

1. Receptacles

Section 210-7(a) states that receptacles installed on 15- and 20-ampere branch circuits shall be of the grounding type. This means that a grounding type receptacle must be used on all new installations. This requirement came into effect in 1968.

If a home or other building was wired before 1968, it is not necessary that good, serviceable, nongrounding-type receptacles be replaced. When nongrounding-type receptacles are replaced, they must be replaced with grounding-type. If, however, the original installation did not include a grounding conductor, the grounding-type receptacle shall (must) be connected to a grounded cold water pipe near the receptacle. If the receptacle is not located near a grounded cold water pipe, and it is impractical to reach one, a nongrounded-type receptacle must be installed. A grounded-type receptacle cannot be used because this would deceive the user into believing that the receptacle is grounded.

The use of grounding adapters for converting nongrounding (2-slot) receptacles to grounding type involves the following risk. It is easy to plug such an adapter into a nongrounding receptacle and connect the spade lug of the green pigtail under the screw that secures the face plate on the receptacle. There are a number of conditions that might exist to prevent effective grounding of the ground terminal of the adapter. (1) The nongrounding receptacle may be fed by cable without a grounding conductor or by the old-fashioned 2-conductor knob and tube wiring. (2) NM cable with a ground wire may be attached to a metal outlet box that is grounded to the ground wire but the face plate and screw that secures it may be nonmetallic. When the spade lug of the green pigtail is attached to that screw, there may be no continuity to the receptacle's metal mounting bracket that is grounded by connection to the box. (3) Perhaps the greatest hazard lies in the fact that the pigtail is often left loose and dangling. It may contact the hot conductor of an adjacent unused receptacle. The current then has a direct conductor to the frame of the portable tool or appliance and provides a shock hazard to the user or anyone who comes into contact with it.

Although thousands of pigtail-type adapters have been manufactured and sold, many insurance and power company inspectors outlaw their use.

The National Electrical Code does not recognize pigtail adapters and makes it clear that their use is a violation. A new style adapter with a fixed grounding attachment is recognized in Section 410-58(b)(3).

Using grounding adapters is a better practice than cutting off the grounding prong from an attachment plug, but their use is not clearly recognized by the National Electrical Code and, as stated above, can be a particularly risky practice.

Section 210-25(b) requires receptacles in every kitchen, family room, dining room, breakfast room, living room, parlor, den, sun room, library, bedroom, recreation room, or similar rooms be placed so that no point along the floor line in any wall space two or more feet wide, is more than 6 feet measured horizontally from an outlet.

The Code requires at least one wall receptacle outlet in each bathroom, adjacent to the basin. Section 210-8 requires that 120-volt, 15- and 20-ampere receptacles in the bathrooms have GFCI protection.

The Code requires one receptacle outlet in each laundry, basement, and attached garage. In a single-family dwelling, at least one receptacle must be installed outdoors and it must be GFCI protected.

Receptacles in the home should be checked with the small portable 3-light neon receptacle testers. These devices will identify 6 errors in wiring grounding-type duplex receptacles. After you have tested the receptacles and are assured of correct wiring, subsequent tests will indicate whether there is grounding continuity.

Receptacle tension testers are used to inspect receptacles for deteriorating contact between the receptacle and the attachment plugs. Small pointers indicate the amount of tension required to withdraw the tester from the receptacle. This tension is compared to a standard, and the receptacle can be replaced when it provides ineffective contact between the outlet terminals and the attachment plug.

Be sure all outdoor receptacles are protected with gasketed spring loaded covers that return to the closed position when released.

m. Home Fires

Usually people can understand that fire is a killer. They can appreciate the lethal hazards of flame, heat, and smoke. However, they do not understand that oxygen is lost rapidly in a fire, and toxic gases are generated. In test fires it has been found that in less than seven minutes after the start of a fire, 22 toxic gases have been emitted into the air. Under these conditions, life functions cease and total destruction is almost certain. The best way to fight an electrical fire is to have a plan to eliminate it.

n. Ground Fault Hazards

The GFCI is a recognized safeguard. Homeowners should be convinced that it is in the family's best interests to use these devices. GFCI's are discussed elsewhere in this unit.

o. Farmstead Hazards

The tables in Section 1 indicate that many electrical accidents occur about the farmstead. Lack of maintenance, misuse of equipment, worn out equipment, insulation that has deteriorated, worn out extension cords, improper use of fuses, poor workmanship have all been discussed as causes for fires and accidents.

It might be well to consider the value in dollars of a steer, the herd bull, or a market hog. What is the loss if one of these animals is electrocuted? One report tells of 5 steers that were electrocuted while getting a drink of water due to a fault in the wiring of an electric pump.

It may seem useless to prepare a map of underground farmstead wiring but one farmer reported stunning several steers at a squeeze chute. The hired man drove a steel post near the chute to anchor a gate and tied the gate in place with wire. The steel post struck an underground conductor and the current traveled through the post and gate to the squeeze chute.

A representative of one large farm insurance company claims that over half of the farm building fires are of electrical origin. He also states that two out of every 100 farm buildings are destroyed by fire each year.

In confinement poultry and swine houses there are times when it is so dry that the concentration of dust in the air is very high. At other times, weather conditions cause condensation of moisture so these same buildings should qualify as "wet locations" in the N.E. Code.

Provide protection for those working in silos, walk-in coolers, etc. If a blackout occurs, turn off all electrical equipment. If all motors are left on the lines, when power is restored, a voltage drop will occur. This may damage motors, cause fuses to blow, and trip circuit breakers.

p. Swimming Pool Hazards

A quick dip in the family swimming pool is refreshing during hot summer weather. However, a piece of poolside electrical equipment can become the instrument of death if damaged or handled in a manner that causes electric current to leak to people. Moisture significantly reduces the skin's capacity to reduce electrical shock. The danger of leakage current is intensified at a poolside location where it is likely that a person's skin will be wet.

The area around a swimming pool is particularly susceptible to leakage current. A defective pump motor, electrical panel board, or underwater light can cause disaster. Appliances used around a pool, such as electric barbecues, radios, television sets, or electric hand tools are also potentially dangerous. The Underwriters Laboratories recommends that you install GFCI's in every circuit that supplies electric power to the swimming pool. In addition to the installation of GFCI's, observe the following safety rules: Never handle radios, barbecues, or other electrical appliances while wet. Never run extension cords close to the pool. Never run overhead wires within ten feet of the pool. Never splice or repair cords of swimming pool equipment. Be sure the electric power supply to the pool is shut off prior to servicing electrical pool equipment. Use pool maintenance equipment designed for that purpose. Plug it into a grounding-type receptacle provided with GFCI protection. Use electrical pool vacuums or sweeps only when the pool is unoccupied. If you feel a tingling sensation when in the water or even approaching the pool, tell someone to turn off all electrical power filtering equipment and appliances in and around the pool. Specifically warn children about the consequences of this hazard.

q. Agriculture Businesses

Explosions and fires occur frequently in mills, elevators, fertilizer plants, etc., that do extensive damage to facilities. Occasionally these result in fatal accidents. Many times there is little attention given to the possibility of electrical hazards as these structures are being built.

The three ingredients necessary for a dust explosion are fuel (dust), oxygen, and energy (flame or spark from electrical equipment).

Good housekeeping is important because the accumulation of dust on pipes and equipment is a potential hazard, causing primary and secondary explosions. The first explosion loosens dust that fuels a second larger explosion.

Two of the principal causes of explosion are wrong kind of portable lights and light fixtures. The common trouble lamp bulb may break, scattering sparks or hot fragments over the area. Permanent light fixtures without reflectors or outer globes can start a fire by igniting dust on the bulb, particularly when the bulb is in a horizontal position.

Improper wiring, open receptacles, and open motors also are fire hazards because of the danger of short circuits or sparks.

All electrical equipment in the mills and elevators that is exposed to dust should have Class II Group "G" rating. This means that the equipment is protected and will operate safely under these conditions. Motors in this Code Classification are totally enclosed and cooled by a fan.

r. Power Line Hazards

Contact with overhead power lines is the predominant cause of farm electrical accidents.

There are a variety of causes for these accidents, but augers and elevators tied for first place with 15 accidents each, or a total of 30. Irrigation equipment accounted for 10 accidents. Some of these were caused by upending pipe and contacting the lines. Others were with powered equipment, such as center-pivot systems contacting the lines. A variety of other causes, such as kites, ladders, tractor loaders, dump trucks, tree trimming tools, television antennaes, etc., are responsible for deaths every year. These hazards are illustrated in a set of transparencies entitled, "Electrical Accidents -- Power Line Hazards," available from Vocational Agriculture Service.

E. When is Grounding Necessary

1. Grounding is a term that is applied in two ways to the electrical system. It refers to the system grounding (connection to cold water metallic piping system) and equipment grounding (connection to the frame of power tools).

2. System grounding. The power company grounds the identified conductor from the transformer to a ground rod or plate on the bottom of the utility pole. This conductor is also grounded as part of the service entrance into the home or farmstead. In most cases the power supplier will specify the location and type of grounding electrode and the manner in which the service box, meter base, etc., are to be bonded to it. In addition, some utility companies require that the equipment be bonded by a grounding conductor to the nearest metallic cold water line. The grounding electrode provides a system so that large voltage differences are minimized.

3. Equipment grounding. If the insulation fails on a power tool (115 V), with a metal frame, the potential between the metal frame and ground will rise to the voltage. If the operator touches ground (a cold water pipe) the 115 V current may flow through the operator to ground causing a shock hazard.

   If the metal frame is bonded by the equipment grounding conductor (green wire) to the system grounding electrode then, the voltage difference will not occur.

   The grounding of an electrical system is one of the most important safety features in the entire system. Grounding offers safety to humans and animals. Contact with equipment not grounded can cause shock and possibly electrocution.

4. Definitions

   Article 100 Definitions, defines a ground: "A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or between some conducting body which serves in place of the earth."

   It defines a grounded conductor as "a system or circuit conductor that is intentionally grounded." This is generally referred to as the neutral. All wiring systems inside a building must have a grounded conductor which is continuously identified throughout the system. Article 200 Use and Identification of Grounded Conductors, Section 200-2, General.

   The grounding conductor is a conductor (wire) used to connect equipment or the grounded circuit to a grounding electrode. An example would be the No. 4 wire between the neutral conductor and the ground rod (electrode).

   Section 250-51, Effective Grounded Path lists three requirements for effective grounding. Basically these mean that the path to ground shall (1) be permanent and continuous (2) have ample carrying capacity and (3) have low impedance (AC resistance).

5. Color Code

   An approved wiring installation makes use of different colored insulation so it can follow a color code. To comply with this code, two-wire circuits have one wire with black insulation and the other with white. Any conductor intended solely for grounding may be bare, have a continuous green color or a green color with one or more yellow stripes. Article 210--Branch Circuits, Section 210-5, Color Code for Branch Circuits (b) Grounding Conductor.

6. Grounding Receptacles

All receptacles installed on 15- and 20-ampere branch circuits shall be of the grounding type and shall be installed according to Section 210-7, Receptacles and Cord Connectors.

In a three-wire service, if one of the hot wires touches the other and is shorted to ground, the voltage is increased from 120 to 240 volts. This will cause damage to 120-volt equipment. The burn-out conditions may start a fire.

Appliances and equipment, such as power tools, washing machines, stock water heaters, and other plug-in appliances, are usually grounded by a third wire in the cord. Unless the grounding conductor of the flexible cord on the appliance is known to be plugged into the grounding conductor of the circuit, handle the appliance as though it were not grounded. A positive safeguard for grounding such equipment is a three-prong plug which can fit only one way into a receptacle. The third prong has its own wire which fastens to the shell of the appliance, and is plugged directly to ground (Article 250 Grounding, Sections 250-46 Spacing from Lightning Rods, 250-42 Fixed Equipment--General, 250-45 Portable Equipment, 250-51 Effective Grounding, 250-60 Frames of Electric Ranges and Electric Clothes Dryers, 250-81 Water Pipe, 250-83 Made Electrodes, 250-92 Installation, 250-115 Ground Clamp).

Use portable testers, such as the 3-light neon receptacle testers as a convenient method of testing whether receptacles are wired correctly and to check the continuity of the ground.

Never fuse the neutral conductor. If you did and the fuse blew, the protection of the ground would be lost.

The neutral conductor is one of the wires in a two-wire 120 volt circuit or a three-wire 240 volt circuit. It is usually grounded and could serve as a ground conductor. A grounding wire, however, is usually connected to the frame or housing of electrical equipment and directly to ground.

7. Portable and Vehicle Mounted Generators

The frames of portable generators need not be grounded if the generator supplies only equipment mounted on the generator or supplied by electrical cords and plugs connected to receptacles mounted on the generator. Article 250-6(a) Portable Generators.

The frames of vehicle mounted generators (recreational vehicles) shall serve as grounding electrodes if the frame of the generator is bonded to the vehicle frame and the generator supplies only equipment through receptacles mounted on the vehicle or on the generator (Section 250-6b).

The neutral conductor shall be bonded to the generator frame (Section 250-6c Neutral Conductor Bonding).

When a portable generator supplies a fixed wiring system, it shall be grounded in accordance with provisions of Article 250-5 Alternating-Current Circuits and Systems to be Grounded.

8. Mobile Home Grounding

The National Electrical Code calls for a 4-wire electrical service to a mobile home. Two wires are "hot" wires, a third is the neutral wire and the fourth is the grounding conductor. In the service panel, there is a neutral bar and a grounding bar. The neutral bar is insulated from the shell of the panel. A separate system of insulated neutrals must be maintained and the neutral conductors must not be grounded inside the mobile home.

This is different from conventional homes because they only require 3-wire service. The metal frame, metal windows, and metal siding of a mobile home must be effectively bonded to the grounding bar. The fourth wire is run from the grounding bar, back to the service pole, not to a driven ground rod or a cold water line.

9. Grounding Bushings

Section 250-72d requires bonding jumpers around concentric or eccentric knockout in service equipment. Eccentric knockout may progress from diameters of one half inch to two inches or larger on a cam arrangement as shown in the illustration. Concentric knockouts progress on a common center. When either of these knockout arrangements is used, and you do not use the entire opening, there is little metal left to provide a complete solid contact with the box enclosure. Electricians find that when a small conduit is used, the larger rings break loose and all grounding continuity is lost downstream from the point where this occurs. Because of the small amount of metal left in solid contact with the enclosures, and the possibility of the rings breaking loose, grounding bushings with bonding jumpers are needed.

F. What is the Purpose of a GFCI?

1. Fault Protection

In 1967, GFCI's (ground fault circuit interrupters) were introduced by the electrical industry as a way of preventing deaths due to ground faults in electrical equipment.

a. Insulation is the usual way to prevent shocks. If insulation was always adequate, there would never be a need for ground fault circuit interfupters. Because insulation is subject to misuse, abuse, and deterioration, steps have been taken to protect us when insulation fails.

b. Grounding, as discussed in Section 4, is one method of providing protection. But in order for it to be effective, it must be continuously connected and be capable of carrying current to ground when necessary. Grounding systems may break down at any time without giving the electrical consumer any indication that they have failed. Sometimes they are deliberately destroyed when the grounding (round or U-shaped) blade is deliberately cut off of attachment plugs. The grounding system is by-passed when someone uses a 2-conductor extension cord to provide power to a 3-wire grounded appliance. We are all familiar with older buildings equipped with 2-wire 120-volt receptables to which there is no grounding conductor.

c. Double insulation is another method of protection used on power tools. The current-carrying parts of these tools have two separate levels of insulation that are not subject to the same degree of deterioration. However, the double insulation does not extend beyond the tool so the user is still subject to the hazards caused by power cords and attachment plugs.

2. Need for GFCI's

Of 92 electrocutions analyzed by Underwriters Laboratories, 89 (96.7%) could have been avoided had a GFCI been used. Double insulation and grounding would have saved only 48 to 50 persons among the cases analyzed.

3. Operation

Based on a study of work accident injuries in California over a 10 year period, the national low voltage industrial accidents have been estimated to be more than 13,500. If ground fault circuit protection could reduce or eliminate this number, it would be a significant savings.

GFCI can be understood by using the analogy of an adding machine. It continuously sums the current flowing out through it to the load and subtracts the current returning through it from the load. If there is no leakage, the machine will register "0". If some of the current leaks, as in the case of a ground fault, the return current will not match the current flowing out. The machine measures the amount of this difference, and if it is greater than the tripping level of the GFCI, it will open the circuit.

A GFCI is a quick acting circuit breaker that is sensitive to a very small current leakage to ground. They are designed so the current-carrying conductors pass through a doughnut-shaped differential transformer. An imbalance in current through the transformer will activate a sensing device that opens the circuit breaker. Most GFCI's are designed to sense 5 milliamperes (.005 ampere) and will trip in .025 second.

The tripping level that has been set is related to the resistance of the body to current flow. Current flow through the body is what causes electric shock injury. The amount of current flow determines the severity of the injury. The amount of current flow depends upon the voltage and the resistance of the body. The length of time the current flows, the parts of the body through which the current flows, and the frequency of the current also affect the severity of the shock damage.

When equipment is used that trips a GFCI, either repair it immediately or discard it. Never let it be used on another unprotected circuit.

Results of field studies indicated that an alternating current of 60-100 milliamperes 60 cycle (60 Hz) per second may be fatal it if passes through vital organs.

Class A GFCI's have a trip value of 5 milliamperes and are used in general applications. Class B styles are used to protect swimming pools and have a trip value of 20 milliamperes.

There are several types available: portable, which can be moved to any receptacle for protection; two receptacle types, one of which will protect other receptacles downstream; and types that install in circuit breaker boxes and resembly a circuit breaker in size and operation.

4. GFCI Classification

GFCI's are classified in the electrical construction material list as follows:

A group I ground fault circuit interrupter is intended to be used only in a circuit that has a grounded conductor.

A group II ground fault circuit interrupter is intended to be used only in a circuit that does not have a grounded conductor.

A class A ground fault circuit interrupter of any group may be used with most utilization equipment. Swimming pool circuits installed before the local adoption of ANSI C1-1965 National Electrical Code are likely to exhibit sufficient leakage current to cause a class A ground fault circuit interrupter to trip.

A class A ground fault circuit interrupter must trip when the current to ground exceeds 5 milliamperes. A class B ground fault circuit interrupter of any group is restricted to use only with underwater swimming pool lighting fixtures, provided also that the fixture is not marked to specify the use of class A ground fault circuit interrupters. A class B ground circuit interrupter must trip when the current to ground exceeds 20 milliamperes.

Section 210-8 of the Code lists requirements for Ground Fault Circuit Protection in dwellings and construction sites.

GFCI's should be used on circuits in the home where electrical appliances and tools are used in potentially wet locations, such as outdoors, bathrooms, kitchens, laundry rooms, basements, and swimming pools.

GFCI's should be used on circuits on the farm where workers use electrical equipment in wet locations, such as dairy barns, milking parlors, confinement livestock, poultry buildings, shops, etc.

In agricultural business, the same combination of electricity and wet locations, such as equipment clean-up areas in farm equipment shops, greenhouses, dairy plants, and food processing plants requires protection by GFCI's.

GFCI's will not protect people from shocks or burns caused by line-to-line contacts.

G. What First Aid is Applied for Electrical Accidents?

1. If you find a person suffering from electrical shock, get him away from the source of current if he is still in contact with it. To remove a person from a live conductor (120-240 volts), turn off the current at the switch, if possible. Move wire or live part from victim by using a dry wooden stick. On 400- or more-volt circuits, it may be impossible to turn off the power. If so, move the wire or live part from the victim by using a very long (10 feet or more) dry (it must be dry) wooden stock. Also be sure you are insulated from the ground or water.

2. Electric shock. As strange as it may seem, low-voltage (120-240) shock is more serious than high-voltage (4000-up) shock. A victim of electrical shock may be suffering from burns, respiratory paralysis, and fibrillation of the heart. High-voltage shock causes burns and stoppage of the heart with unconsciousness.

   In the Rural Accident Prevention Bulletin, "Electrical Safety on the Farm and Ranch," Bill Fletcher of the National Safety Council makes these recommendations:

Time is critical to any victim of electrical shock. He might be suffering from respiratory paralysis, heart fibrillation, or both. In addition, he could be severely burned.

If breathing stops, irreversible brain damage typically occurs somewhere between four to six minutes. The time limit on arrest of normal heart action is similar. After this, even if you could restore heart action and breathing, the victim probably would suffer permanent brain damage. Therefore, the urgency of acting before this four to six minute "grace period" to get oxygen flowing to the vital organs cannot be emphasized too strongly.

First cut off the power. If that is not possible, move him or the power source away with a wooden pole or board. Do not touch him until after this is done or you might also get shocked.

Any shock victim needs help fast--but if he is unconscious and not breathing, it is a life-or-death emergency. Send a bystander to the phone or yell for someone to call for emergency medical help. If you are alone and out of earshot, dash to a phone but only if you can make the round trip within a couple or three minutes. (Remember the four to six minute grace period.)

Unfortunately, most farm or ranches are more than four to six minutes away from a doctor or emergency medical team, so you must be prepared to take immediate action to preserve the spark of life until help arrives. If the person is not breathing, begin mouth-to-mouth resuscitation (see steps one and two below). If there is also no pulse, coronary-pulmonary resuscitation (CPR) should be attempted. For CPR, it is very helpful to have two persons--one to handle the breathing and the other to perform chest compression. But one person can do both if necessary.

The CPR technique has three basic steps:

a. The first step is to open the victim's airway. Lift his neck up with one hand while pushing on his forehead with your other hand to tilt his head back.

b. Pinch the victim's nostrils closed with your finger and thumb, take a deep breath, place your mouth over his mouth and blow. His chest will expand as his lungs fill with air. Move your head away and allow the victim to exhale. Breathe into his mouth once every five seconds until his own breathing starts or expert help arrives to take over.

c. To keep the victim's blood moving to his brain and other vital organs, it is necessary to squeeze his heart. Place the heel of your hand over the lower part of his sternum, directly over his heart. Keep your arm stiff and push down 1½ to 2 inches. Squeezing the heart this way will push blood out so it can be refilled with new blood. If there are two rescuers, one should breathe into the victim's mouth while the other compresses his heart 60 times a minute.

If you are alone, breathe twice into the victim's mouth then press his heart 15 times. The two breaths to 15 compressions should be followed until help arrives.

For electrical or other emergencies, someone or several persons on the farm or ranch should be trained in these resuscitation techniques, preferably through Red Cross or another recognized course.

H. How Are Electrical Fires Controlled?

1. Electrical Fires are termed Class C fires. To fight a Class C fire remember these steps.

   a. Make sure everyone in the building is told of the fire and is evacuated immediately

   b. Call the fire department

   c. Fight the fire with first aid fire-fighting equipment until the fire department arrives

      1) Carbon dioxide (CO_2) is excellent for fighting Class C fires. It extinguishes a fire by lowering the kindling point and cutting off the oxygen at the same time. It is ideal for dwellings because CO_2 evaporates, leaving no residue.

      2) Dry chemical is excellent for fighting Class C fires. Out-of-doors, dry chemical is rated superior to carbon dioxide because,

using equal amounts, dry chemical will extinguish a fire twice the size of one that CO_2 will extinguish. The only drawback to dry chemical is the powdery residue.

d. If no extinguisher is available, use baking soda or salt to extinguish an electrical fire, but never use flour or water. Flour is combustible and when the particles are suspended in the air, the flame will ignite them causing a flash or an explosion. Water is a conductor of electricity and can carry the current through the person holding the hose or water-type extinguisher to the ground, causing electrocution. Water may be used if the power is shut off, the operator is not grounded, or the water is applied as a fog. These requirements, however, may be forgotten during the excitement and confusion of a fire, so the general recommendation not to use water should still apply.

The discontinuation of the electrical service due to power outages as well as repairs on rural lines has caused some accidents that are actually unrelated to electricity. Fires have resulted from the use of candles when electrical power has been shut off. There have been other instances in which phones have been disconnected and water shut off due to discontinuation of electrical service. In these instances, homes have burned because the owners were unable to report the fires or had no water with which to fight the fires.

I. What Activities Will Identify Hazards?

1. Since we all are using electricity every day and are enjoying the benefits and conveniences it provides, we should periodically review some general safety rules.

2. General Safety Rules

   a. Check the circuit for cause of burned out fuse before replacing it.
   b. Safety devices (fuses and circuit breakers) are designed to prevent overloads; however, occasionally they fail to function.
   c. Always replace fuses with one of the proper rating for the circuit.
   d. Use ground fault circuit interrupter on circuits to protect people where they may be grounded when using electrical appliances.

e. Know the location of the first aid kit.
f. Insist that every injury receives medical attention regardless of how minor it seems to be.
g. Administer first aid to people receiving electrical shock only if you have proper knowledge.
h. Follow the National Electrical Code and the local regulations for safe and approved wiring.
i. Do not use any equipment which produces a slight shock when operated.
j. Operating a switch is hazardous when standing in water or on a damp floor.
k. Never operate electrical appliances of fixtures from the bathtub or with your hand in a sink.
l. Do not touch or move broken electrical wires lying on the ground. Report them to the police department or power company.
m. Use a very dry stick or well insulated material to move a fallen wire or a person lying on a live wire.
n. Never turn on the power until you have notified all family members or other workers in the area.
o. Do not operate switches without knowledge of their purpose.
p. On all occasions be aware of the hazards of electricity and acquire skill in preventing accidents.
q. Run a current leakage check on portable power tools. Check on continuity of grounding conductor.
r. Check receptacle outlets for polarity and proper grounding.
s. Do not carry electrical power tools with your finger on the trigger switch when they are plugged in.
t. Do not use ungrounded portable electric tools and equipment unless they are double insulated.
u. Do not remove grounding connections (third prong) from power tools.
v. Buy and use electrical equipment that meets the approval of Underwirters Laboratories.
w. Use explosion-proof or vapor-proof fixtures in areas where there is dust or volatile fumes.
x. Do not permit trash or rubbish to accumulate near electrical equipment.
y. Disconnect electrical cords by pulling on the plug.

3. Specific safety rules for electrical workers when working with electrical appliances or electrical wiring

   a. Turn off the power supply, then work on the electrical circuits as if the power is on--remember that "unloaded guns kill." Use a neon glow tube tester to check for power.
   b. Never wear metal rings, bracelets, watch bands, or chains while working on the electrical equipment.
   c. Never check circuits with fingers to see if they are "hot."
   d. Wear safety glasses when wiring or repairing electrical equipment.
   e. Plan your work so you always know exactly what you are about to do.
   f. Never take a chance and touch one wire, thinking it is the ground wire.
   g. Always have another person with you while you work on high voltage. It is a risky practice to work on electrical equipment alone.
   h. Always wear rubber-soled shoes, stand on a rubber mat or dry board without nails, and work as if the wires are "hot" when repairing or installing electrical equipment in a damp basement.
   i. Always work one side of a circuit at a time. This minimizes the danger of closing a circuit with your body.
   j. Make the final connection at the source of power after the electrical equipment and circuits have been checked against the wiring diagram.
   k. Properly ground all equipment for prevention of accidents and fatal injuries.
   l. When the source of power is turned off, the same person who directed it to be turned off should always turn it on.
   m. Avoid conversation with other workers because it may distract them and cause an accident.
   n. Handle all electrical components with care--five and ten watt resistors get very hot and may give you a third degree burn. Vacuum tubes get very hot in use; wait for them to cool before handling them.
   o. Capacitors retain a charge which sometimes causes burns or a fatal shock.
   p. Do not heat soldering irons to the point at which they become red hot. Soldering irons and guns should be placed or stored after use in such a manner that someone is not accidentally burned.

q. Never shake hot solder off when desoldering joints because you or your neighbor may be hit in the eyes, face, body, or clothes.
r. Always select the proper tool for the specific job.
s. An orderly work bench will help prevent accidents and injuries.
t. Replace all two wire input cords and plugs with three wire cords and plugs.
u. Never disconnect ground wires leading from electrical fixtures.
v. Properly ground all electrical power tools.
w. Check all electrical cords for breaks in the insulation.
x. Inspect droplights to see that the socket, plug, and guard are in good condition.
y. Use battery powered lights of not more than twelve volts in wet or damp places.
z. Always lock or tag deenergized circuits so others will not turn on the power supply.
aa. Do not use metal ladders while working on electrical equipment.
bb. Determine the type of current prior to repairing or replacing wires.

4. Circuit Survey

The circuit survey is designed to determine the electrical load on each circuit and can be used to determine the total load in a building. Each circuit requires a separate survey sheet, so a building with 5 circuits would require 5 survey sheets.

Use a receptacle tester to determine if the circuit has a grounding conductor and if the receptacles are wired correctly.

When making the circuit survey, assume that all applicances on the circuit could be in use at one time. Assume that additional portable appliances or tools are plugged in.

The wattage, or amperage, of electrical equipment can usually be found on a nameplate or stamped on each electrical item.

Use a wire gauge to determine wire size. If the end of the conductor is inaccessible, take new pieces of wire (Size No. 14, 12, 10, 8, 6) with sizes marked on them and hold alongside old wire for comparison. The size should be marked on the insulation of new wire or on the sheath of NM and UF cable.

5. Electrical Hazard Surveys

Electrical hazard surveys are part of a systematic maintenance program for the electrical equipment in homes, farms, and businesses. Such a maintenance program includes:

a. Conducting careful, frequent, scheduled inspections of electrical equipment.
b. Listing of repairs needed.
c. Recording dates of repair, change or replacement of electrical equipment.
d. Recording cause of electrical equipment failure.
e. Recording whether cause of equipment failure was corrected.
f. Maintaining a file on electrical equipment.

    1) Source of supply
    2) Specifications
    3) Date of purchase
    4) Type and frequency of service

Electrical accidents and fires do not "just happen" they are caused. The prevention of fires and accidents can be accomplished by a positive continuous program of education and systematic electrical inspection. The inspection program is designed to identify electrical hazards that exist and conditions that are potential hazards.

The visual inspection should include electrical panels, motors, controls, switches, lights, receptacles, cables, conduit, and cords. The inspection should also include checking for broken, damaged or worn plugs, switches, receptacles, conductors, insulation, cover plates, connections, etc. The inspection should note the presence of oil, water, trash, dust, etc., as it might affect motors and electrical equipment.

After electrical hazards are identified, the same list can be used to schedule repair, replacement, and elimination of the hazards. This may include grounding of equipment, replacing plugs or cords, installing GFCI's, cleaning motors and equipment, adding circuit extensions, or even rewiring. The regular use of checklists may lead to the establishment of scheduled preventive maintenance procedures that will prevent premature failure of electric motors and extend the life of protective insulation.

The following checklists should be completed on the home, farm, and agricultural businesses on a regular basis. These checklists are designed to be reproduced and used along with an educational program on electrical hazards to help the user become more conscious of electrical hazards. Additional items may need to be added to these basic lists.

Each facility has a question as to whether the service entrance is properly grounded. This is a most important part of the electrical system. The ground rod must be of proper size, type, and length. The clamp must securely bond the ground conductor to the ground rod and protect against mechanical damage. It may be necessary to dig down and check this if you cannot determine it any other way.

J. Fundamentals of Electricity

It is not known exactly what electricity is, but if you accept certain beliefs that are widely held, you can understand how electricity works. An electric current may be considered to be a flow of tiny particles, called electrons. Electrons move around the nucleus of an atom. Collectively they can transmit tremendous quantities of energy which can be harnessed to produce heat, light, and power.

Most of the electrical energy used on farms comes from large generating stations where steam turbines, water power, or nuclear energy are being used to develop electrical energy.

1. Voltage

Electrons flow through a circuit because of electromotive force (EMF) or voltage. Voltage is the pressure that causes electrons to flow somewhat like water in a water system. Voltage may vary from 1½ volts in a flashlight cell to thousands of volts in major power transmission lines. Between these extremes are the 12-volt systems in cars, trucks, and tractors; 10- to 24-volt circuits used for door chimes, electric trains, and various types of relay controls; and the 120- and 240-volt circuits commonly used on the farm for heat, light, and power.

Voltage is measured with a voltmeter. It is connected across two wires of the circuit and measures the difference in electrical pressure between them. A voltmeter is comparable to a pressure gauge on a water pipe. The main difference is that the pressure gauge is attached to only one pipe, while the voltmeter must be attached to both wires.

Voltage of an alternating current can conveniently be stepped up or down by a transformer. Electrical energy, like water, can be transmitted in large quantities over long distances with relatively small conductors (pipes) if the voltage (pressure) is high enough. At the generating station the voltage is stepped up to as much as 240,000 volts so that a tremendous amount of energy can be carried long distances over wires that are practical in size. As it comes near the point of distribution, substation transformers step this voltage down to a few thousand volts, which is suitable to carry on poles along farm roads. At each farm a transformer further steps the voltage down to 240 and 120 for safe, practical control on the farmstead.

The transformer consists of two coils of insulated wire wound around a soft iron core. The primary coil is connected to the high-voltage line that passes from farm to farm. The secondary coil is connected to the wires leading to the farmstead.

There are usually three wires leading from the transformer to the farmstead wiring system. From these three wires, two different voltages are obtained--120 and 240. Lights, small appliances, and small motors use the lower voltage. Large appliances and large motors require the higher voltage.

2. Neutral and Hot Wires

At the time the transformer is installed, the power supplier connects a wire, brings it down the pole, and attaches it to a ground rod or plate that is buried in the earth. This makes the wire a "neutral." This means that if you are standing on damp ground, or are in contact with a water pipe or other grounded metal object, you will not receive a shock when you touch the neutral wire. In electrical terms we may say that the nuetral wire and the earth are of the same polarity. If, however, your body is in contact with the earth in some way and you touch either of the other two wires, you will receive a shock. Current travels through your body and back to the source through the earth. These wires are, therefore, called "hot" wires.

3. Amperage

As stated previously, electric current is a flow of electrons. The number of electrons that pass a certain point in a given length of time determines the amount of work the current can do. The flow of current is expressed in amperes, or amps. A current of one ampere means that 6,285,000,000,000,000,000 (six quintillion, 285 quadrillion) electrons pass a given point in the circuit in one second. This is approximately the energy used by a 100-watt lamp.

Amperes are measured by an instrument called an ammeter. The ammeter is attached in one line so that all of the electrons in the circuit pass through it. This is comparable to a meter installed in a water pipe to measure the gallons flowing through.

4. Wattage

Electrical power is measured in watts. A watt is the power delivered by one ampere of current flowing at a pressure of one volt. The relationship of watts to volts and amps may be expressed by the following:

volts x amps = watts
volts = watts ÷ amps
amps = watts ÷ volts

If two of these factors are known, the third may be computed. For example, how many amps does a 300-watt bulb require at 120 volts?

Answer: amps = 300 ÷ 120 = 2.5

The relationship between volts, amps, and watts are exactly true only for lights and heating devices. They are not strictly true for motors.

Electric motors are generally rated in horsepower and usually have information on the nameplate as to the number of amperes required to operate the motor at a certain voltage. If they do not have this information, you can usually change horsepower to watts.

One horsepower is equal to 746 watts. However, due to certain losses in efficiency, a rule of thumb considers one horsepower to be equal to approximately

1000 watts. Fractional horsepower motors require as much as 1200 watts per horsepower. A 1/3 horsepower motor would use about 400 watts while a two horsepower motor could require approximately 2000 watts.

Since a watt is a small unit of power, it is often more convenient to speak in kilowatts (1,000 watts). Most electric power suppliers charge their users of electric service on the basis of kilowatt-hours (kwh). A kilowatt-hour is 1,000 watts of electric power, or its equivalent, used for one hour. A 1,000-watt electric iron uses 1 kilowatt-hour each hour, while a 200-watt lamp will burn 5 hours on one kilowatt-hour.

A kilowatt-hour is equivalent to 2,655,000 foot-pounds of work. One foot-pound is the amount of work required to move one pound a distance of one foot. If you lift a 100-pound sack of feed two feet, you will have done 200 foot-pounds of work. If you did this once each second for 3½ hours, you would have done work equivalent to one kilowatt-hour of electricity.

A kilowatt is part of the metric system, while a horsepower is part of the English system. One horsepower is the force required to move 550 foot-pounds per second (33,000 per minute). One horsepower working for one hour is equal to about 3/4 kilowatt-hour (550 ft. lbs. x 60 sec. x 60 min. = 1,800,000 ft. lbs.).

If a man shoveled 100 bushels of wheat an hour from a truck into a bin opening five feet above the truck, he would perform 30,000 foot-pounds of work. That would be about 1.2 percent of a kilowatt-hour. The potential work in one kwh could unload 8,850 bushels in the same hour.

A kilowatt-hour is equivalent to the work done in the following jobs:

Mix one ton of feed.
Shell a ton of corn.
Power a grinding wheel for nine hours.
Mix two yards of concrete.
Ventilate a hog house (with 50 hogs inside) for one day.

The instrument used to measure the electric power used on the farm is the kilowatt-hour meter which is installed by the power supplier as part of the main farm entrance. Since this meter measures both voltage and amperage, it is connected across the line as a voltmeter and in the line as a ammeter.

5. Resistance

Just as there is friction which interferes with the flow of water in a pipe, electrical friction, or resistance, affects the flow of electrons through an electrical circuit. At a given water pressure, high friction reduces the amount of water that will flow through a pipe and low friction increases it. Likewise, at a given voltage, high resistance means smaller current flow and low resistance means larger current flow.

Electrical resistance is measured in ohms and the instrument used to measure resistance is called an ohmmeter. There is a relationship between voltage, current, and resistance that is expressed as follows:

volts = amps x ohms

amps = volts ÷ ohms

ohms = volts ÷ amps

If any two of these factors are known, the third may be computed. For example, how many ohms resistance does the 300-watt bulb (2.5 amps) have?

Answer: ohms = 120 ÷ 2.5 = 48

How many amps of current at 120 volts will flow through a circuit having a resistance of 8 ohms?

Answer: amps = 120 ÷ 8 = 15

Resistance is undesirable in some cases and is sought after in others. Resistance in a wire or conductor causes a loss of energy. Wires are therefore made of low-resistance materials like copper or aluminum to keep these losses to a minimum. The filament of a lamp bulb or the element of a heating appliance makes use of metals and alloys having high resistance. The tungsten filament of a lamp bulb heats white-hot when current is forced through it. The nichrome element of a toaster becomes red-hot when current passes through it. Thus, resistance is useful in these devices.

Some materials like procelain, glass, rubber, and some plastic substances have such high resistance that, for all practical purposes, no current flows through them at all at ordinary voltages. We call these materials insulators and use them to stop the flow of electricity or confine it to the paths in which we intend for it to flow.

6. Electrical Arithmetic

There are several methods of determining the cost of using an electrical appliance. Two of these methods involve the use of a watt-hour meter. Some watt-hour meters read like the odometer on an automobile, while reading a meter with a pointer-type register involves a special technique.

If the kilowatt hour meter has a pointer-type register, read the nearest number on the right-hand dial and the last number passed on the other dials. Each dial contributes one digit to the meter reading. A number is counted only if the pointer is on or has fully passed that number. You may need to check the next dial on the right for the correct reading.

Ohm's law is often written:

$$\text{Amperage} = \frac{\text{Volts}}{\text{Ohms}}$$

This law is so essential to understanding electricity that is should be memorized. An easy way to do this is to learn the relationship.

Voltage (pressure) = E
Amperage (current) = I
Ohms (resistance) = R

The basic formula can be written three ways:

Amps x ohms = volts	$I \times R = E$
Volts ÷ ohms = amps	$\frac{E}{R} = I$
Volts ÷ amps = ohms	$\frac{E}{I} = R$

A similar formula is called a power equation:

Watts = amps x volts

Amps x volts = watts $I \times E = P$

Watts ÷ volts = amps $\frac{P}{E} = I$

Watts ÷ amps = volts $\frac{P}{I} = E$

Power can also be calculated with voltage and resistance. Ohm's law can be stated as $I = E/R$. If this equivalent is substituted for I in the power formula $P = E \times I$, it becomes $P = E \times E/R$ or $P = E^2/R$. In addition, the Ohm's law equivalent of $E = I \times R$. If this equivalent is substituted for E, the power formula becomes $P = E \times I$ or $P = (I \times R) \times I$ or $P = I^2 \times R$.

K. Safety and Adequacy

Safety and adequacy should be the first requirements when wiring a building, adding an outlet, or replacing a switch.

Safety measures are often neglected. Each year approximately 1000 persons are killed by electricity and 27 percent of these deaths occur in the home. It is not uncommon to see circuits overloaded and fuses used which are too large for the size of wire; unsafe "temporary" additions made with extension cords, or worn and frayed lamp cords hooked over nails, running under rugs, or in contact with combustible materials. These conditions may result in inefficient operation of electrical equipment, shock hazards to humans and animals, and even a disastrous fire.

Adequate wiring insures sufficient capacity for present and future needs.

1. Safety

a. UL Approved

Be sure that all materials used are approved by Underwriters' Laboratories (UL). This organization, supported jointly by manufacturers, insurance companies, and others interested in safety, inspects and tests the quality of electrical devices and materials to see if they meet minimum standards. The Underwriter's label on a switch, receptacle, fixture, or roll of wire is your assurance of safety when the item is properly installed, maintained, and used for its intended purpose.

b. National Electrical Code

Next, be sure that all wiring is installed according to the requirements and recommendations of the National Electrical Code. The Code is a set of rules sponsored by the National Fire Protection Association primarily for safety in electrical wiring. For example, the Code states that overcurrent devices (fuses or circuit breakers) protecting circuits using No. 14 wire shall have a rating of not more than 15 amperes. This has been determined to be the maximum current that can be carried safely on a No. 14 wire for extended periods without heating the wire to the point of danger from fire. Another example of a Code ruling is that the identified conductor (white wire) shall be connected to the screw shell of a lampholder. This is to prevent the danger of getting a serious or fatal shock if you should touch the base of a bulb while standing on a damp floor. Numerous other examples could be given.

The National Fire Protection Association publishes the Code which merely sets up the rules, but they have no legal power to enforce them. Many local areas, however, have passed laws making the Code rules mandatory. Some cities require electrical installations to comply with stricter regulations than those in the Code. Most rural electric cooperatives follow the Code very closely and in many cases enforce rules that are more strict than the National Code. All existing electrical work must be made to conform with sections of the current Code in order to comply with Occupational Safety and Health Act (OSHA). Compliance with the provisions of the Code can effectively minimize fire and accident hazards in any electrical system. Safety, however, is not guaranteed by simply observing Code rules. The actual layout and installation of an electrical system requires the use of good judgment and the constant consideration of safety.

You should study the Code carefully and become familiar with the important rulings that apply specifically to farm and home wiring. Even if you live in an area where the Code is not strictly enforced, it is still in your best interest to follow it and to insist that others who install wiring for you do the same.

c. Grounding

Grounding provides a substantial measure of protection against faults caused by insulation failures. Grounding connections, however, are subject to abuse and deterioration, and may be so corroded that the grounding system in unable to carry a fault current when one is imposed on it. Grounding is described in Article 250 of the National Electrical Code. A grounding system, that has not been properly maintained, may be ineffective or even cause a dangerous condition. A broken grounding connection may go undetected for years. Some have been made useless by breaking off the grounding pin on the attachment plug, or by failing to attach the grounding connection on an adapter to a grounded cover-place screw when a 2-wire receptacle is used. Grounding wires can be converted into a lethal condition if the color coding of the conductors has been ignored or if an unconnected adapter pigtail contacts a live conductor.

d. Overcurrent Protection

Fuses and circuit breakers are used for the following reasons:

1) To protect a circuit from damage from an overload. An example would be using a waffle iron (1200 watts), toaster (1100 watts), and a percolator (600 watts) on a 20-ampere circuit whose maximum load is 2400 watts (120 v. x 20 amps. = 2400 watts).
2) To protect a circuit from damage from a short circuit. An example would be a frayed extension cord leading to a portable power tool.
3) To interrupt as small a part of the electrical system as possible. If a mouse gnaws the insulation on the wires leading to a motor and a short circuit occurs, it should not shut down all electrical service to the farmstead. The protective device should limit the outage to the area affected.

Fuses and circuit breakers are installed in circuits to protect against damage to equipment and conductors. They are the safety valve in an electrical system and it is dangerous to replace fuses with larger ones or to tamper with circuit breakers.

e. Ground-Fault Interrupters

These devices are relatively new and there is considerable interest in them as safety devices so their function and application is described in detail.

A ground-fault condition exists when an unintended path is established between an ungrounded conductor and ground. Sometimes the housings of portable, electrical tools or appliances have a small current leak. A fault current will follow the path of least resistance and this path may be through a person rather than over a poor grounding conductor. A good grounding system (the green wire in a cord, rigid metal conduit, etc.) will carry off this leakage current.

Ground-fault circuit-interrupters have been called "people protectors" to separate their function from that of fuses and circuit breakers which are primarily "equipment protectors."

The ground-fault circuit-interrupter (GFCI) is not a new concept. Devices of this nature have been used successfully in other countries for more than 20 years. They were originally developed for the protection of personnel from industrial circuits. The GFCIs available today are based on the advantages of solid-state electronics. This equipment has greater sensitivity to the flow of very small currents, and has brought about a much faster "tripping time" for circuit breakers.

The National Electrical Code, Section 680-4(F), defines the GFCI as follows: "A ground-fault circuit-interrupter is a device whose function is to interrupt the electrical circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the over-current protective device on the supply circuit."

Insulation provides protection against ground faults and if adequate insulation were always present, there would be no ground faults. Abusive handling damages insulation, and age deteriorates it, so use and age combine to increase the probability of ground faults as equipment gets older.

The majority of electrical shock injuries occur through accidental contact with a live conductor while a portion of the body is in ground contact. Body resistance varies with the amount of moisture present on the skin, the muscular structure of the body, and the voltage to which the body is subjected. If the ground contact is poor, that is, the person is wearing rubber-soled shoes or standing on thick carpeting, etc., the voltage will not be able to force a harmful current (amperage) through this resistance. But if the ground contact resistance is lowered by perspiring hands or contact with grounded metal or damp concrete floors, the same voltage will be able to force a large current through the body. If the current passes through the heart or head, a fatal accident may occur. This type of electrical contact is called a "ground fault," as opposed to a "short circuit," where two or more circuit conductors are crossed.

Even at very low current levels, contact between an energized equipment enclosure and a grounded conductor may give rise to arcing, causing fires and explosions, and if the line to ground path includes a human being, serious injury or electrocution may result. Ventricular fibrillation is a disruption of normal heart rhythm which, without prompt medical attention, results in death. It may be caused by very small currents.

Fuses and circuit breakers are designed primarily to protect the circuit conductors and equipment. Their current settings do not permit them to respond to the minute currents associated with ground faults.

A current flow of as little as 9/1000 of an ampere can freeze a person to the power source so that he cannot let go, and as little as 50/1000 of an ampere can induce ventricular fibrillation. GFCIs are designed to sense and respond to such currents. A GFCI is not a substitute for a fuse or circuit breaker. Instead, the GFCI complements this essential part of the electrical system and offers additional personnel protection.

Some manufacturers of equipment have used the double insulation as an alternative to grounding. Underwriters' Laboratories require that equipment listed in this category have two distinctly separate systems of electrical insulation. Yet this system, too, has limitations. Double insulation only protects the user from faults which occur within the device itself. It does not protect the user from faulty cords and plugs. Double insulation may not protect the user if the equipment is dropped in water.

GFCIs are available in several types and circuit designs. Two basic fault-current sensitivities are 5 milliamperes (5/1000 ampere) and 20 milliamperes (20/1000 ampere). The 5-milliampere GFCIs are general purpose models. The tripping time, the time it takes the GFCI to detect an open circuit, will vary with the voltage and fault-current sensitivities, but the net result to the user must always be the same; that is, the GFCIs must open fast enough to prevent an electrocution.

Many GFCIs open in 25/1000 sec. depending on the amount of current leakage. This does not mean that the user will never experience a shock under fault conditions. The user probably will receive a shock, but it will be sufficiently below the combined time-current values to prevent electrocution to a normal healthy person.

The most widely used type of GFCI employs a doughnut-shaped differential transformer. The circuit conductors are fed through the hole in the transformer to the load, and the transformer is connected to a circuit breaker through an electronic detection circuit. The GFCI continually matches the current into the load against the current out of the load. Whenever a hazardous amount of current seeks ground any other way but over the circuit conductors, an imbalance is created and the GFCI will open the circuit. The GFCI will open on both 2-wire and 3-wire (equipment grounding) systems and it will monitor the system continually.

It is important to recognize that a GFCI will not protect the user from line-to-line contact hazards. It is not intended as a substitute for good electrical safety procedures. Its protection is solely against the most common form of electrical shock hazard, the line-to-ground fault. In ground-fault situations, which do not include human beings, the ground-fault impedance (AC resistance) may occasionally be quite low, such as would almost certainly open the circuit before the GFCI could react. Under no circumstances should the GFCI be tested by touching a live conductor to ground. GFCIs are equipped with test buttons and should be tested regularly. In permanently installed models, the test should be noted on the record card supplied by the manufacturer. In addition to permanently installed models, portable GFCIs are available for special protection of portable equipment.

GFCIs should be used wherever water, electricity, and people are in close proximity or where the user of electrical equipment cannot avoid being grounded. They should also protect circuits providing power to portable pools and outdoor receptacles. GFCIs are used today in such places as greenhouses, irrigation systems, dairy barns, boat docks, swimming pools, work shops, laundry rooms, kitchens, bathrooms, and patios. In addition to the portable models of GFCIs, miniaturized versions are combined with an ordinary duplex receptacle and others are molded into the case of circuit breakers and provide even broader protection.

The 1971 National Electrical Code recognized the necessity for this type of protection and extended the mandatory GFCI requirements to the following areas:

1) All 15- and 20-ampere receptacle outlets on single phase circuits for construction sites (Sec. 210-7)
2) For residential occupancies all 120-volt single phase 15- and 20-ampere receptacle circuits installed outdoors (Sec. 210-22d)
3) All receptacles located between 10 and 15 feet of the inside wall of swimming pools (Sec. 680-6)
4) All electrical equipment used with storable swimming pools shall be supplied by circuits protected by ground-fault circuit-interrupters (Sec. 680-31)

f. Lighting

Proper illumination is an essential part of modern living and working. The amount of illumination and the type of illumination should be fitted to the various home and farm tasks. Adequately lighted work areas and farmsteads provide a safer place to work.

g. Fire Prevention

Studies of the incidence of fires in poultry confinement buildings show that dust and moisture at cleaning time have combined to create fire hazards. The following are some recommendations to help prevent fires of electrical origin in farm buildings:

1) Locate service switches, distribution cabinets, and over-current protective devices in a separate entry room that is protected from dust accumulations.
2) Mount these devices on fire-resistant material, such as asbestos-cement board.
3) Space mounting panel one inch away from outside wall to provide an air space between panel and inside surface wall.
4) Seal voids between service entrance conductors and conduit to restrict movement of water vapor.
5) Use UF cable for circuit conductors rather than conduit wiring. This eliminates condensation of moisture in conduit.
6) Mount UF cable so it is visible at all times.
7) Use special threaded fittings with neoprene seal to secure UF cable to boxes. This will form a dust and water-tight connection.
8) Protect bulbs with glass globes.
9) Cover receptacles with gasketed, spring loaded covers that automatically close when not in use.
10) Use dust-tight connectors on all conductors providing electirc current to equipment (feeder motors, ventilating fans, etc.).
11) Use totally enclosed, fan-cooled motors.
12) Place motor controllers in dust-tight enclosures.

While these recommendations increase the cost of wiring, they provide an increased feeling of security due to the reduced fire hazard.

2. Adequacy

Adequacy of wiring, for the future as well as the present, should always be considered. Every electrical system should have sufficient capacity to serve the loads for which it is designed, plus spare capacity to meet anticipated growth.

Adequacy means such things as having the main service of proper size and location, having plenty of current available at each building or point on the farmstead where electric power is desired, and having sufficient circuits, outlets, lights, switches, etc., in each building for efficient, convenient operation.

What was considered adequate wiring two or three decades ago, when many farms were electrified for the first time, is just as inadequate today as tractors and farm machinery of that period would be. As an example, many farms were wired originally so that the farm dwelling was the load center. The power supplier brought the wires from the transformer to the side of the house nearest the road, located the meter there and the main entrance box was placed inside the house. This was an expedient arrangement and was satisfactory as long as the principal electrical load was in the house. Today many farmers use far more current in other farm buildings than in the house and the original service has become a serious "bottleneck."

Generally, the power supplier brings the distribution line to the farm. The transformer may be located on a pole or power may be brought in with underground service and the transformer located on a concrete pad.

The service from the transformer to the metering points is known as the service drop. An adequate farm electrical system usually starts with a load center, with current delivered to each farm building by feeders. This system generally provides the greatest overall economy in wiring cost and has several recognized advantages:

a. It provides protection from fire since a direct line can be run to the water system. Loss of one building by fire will not necessarily interrupt service to the pump or other buildings.
b. Heavy farmstead electrical loads are kept as close as possible to the load center.
c. Feeder wires to each individual building can be sized according to the load expected in that building.
d. It is easy to connect service to new locations from a central load center.
e. It is easy to disconnect service to one building without interrupting service to other buildings.

The size of the main farm service depends on the load it must carry now and in the foreseeable future. Although a 60-amp service was considered adequate a few years ago, the minimum size now should be a 100-amp service and most power suppliers recommend service of 200- or 400-ampere capacity.

L. Planning the Wiring System

When planning the wiring system, consider the general recommendations for farm buildings. Select the location and number of lighting outlets (devices to which various fixtures are attached), convenience outlets, switches, outdoor lighting and use the symbols shown in Appendix D. After this, plan the specific requirements that determine the size and number of branch circuits, the size of entrance equipment, the size of feeder wires, and eventually the size of the main farm service entrance.

1. General Recommendations

a. Lighting Outlets

Use lamp holders with nonmetallic covering, such as porcelain, plastic, or rubber for wet and damp locations. The lighting fixtures in feed grinding rooms, feed storage rooms, haymows, and other dusty locations should be dust-tight.

Two lighting outlets should be used for each stairway unless the head and foot of the stairway are adequately lighted from other sources. Provide one outlet for every 20 feet of the main passageways. These outlets should be wall-switch controlled. Locate the switches outside of stairwells. Use three-way control where exit is normally made without retracing one's steps. Main stairways and passageways in barns are narrow and steep and need special lighting. These recommendations generally provide for sufficient lighting for safety but additional outlets may be needed at landings or where passageways are not straight.

b. Convenience Outlets

Locate convenience outlets in farm buildings as high as they can be reached conveniently. For additional protection from physical damage, these outlets should be mounted between the studding, or flush with the surface of the wall.

All convenience outlets in farm buildings must be 20-ampere duplex outlets of the grounding type. In special cases the outlet may be attached to a drop cord suspended from the ceiling provided that the cord is of the proper type for the location.

In the farm home, convenience outlets should be located near the end of wall spaces rather than near the center. This reduces the likelihood of being concealed behind large pieces of furniture. Unless otherwise specified, the outlets can be located approximately 12 inches from the floor line.

c. Wall Switches

Locate wall switches at the latch side of doors or the traffic side of arches and within the room or area in which the light is controlled. Exceptions to this practice include the control of exterior lights from indoors; the control of stairway lights from adjoining areas; and the control of lights in infrequently used areas, such as closets and storage areas.

Wall switches are normally mounted approximately 48" above the floor line except in buildings where they are subject to damage by livestock. In these instances, they should be located as high as can be reached conveniently.

Equip all spaces for which wall switch controls are required and which have more than one entrance, with multiple switch control at each principal entrance except when one entrance is within ten feet of another.

d. Outdoor Lighting

Modern mechanized farm operations require increased use of outdoor lighting. The nighttime farm operations that require lighting are:

1) Equipment use, storage, and maintenance.
2) Livestock feeding and handling.
3) Product handling and storage.

When planning a wiring system, some lighting standards developed by the Illuminating Engineering Society (IES) should be kept in mind.

e. I.E.S. Minimum Illumination Standards

Farms	Footcandles
General inactive areas (protective lighting)	0.2
General active areas (paths, steps, storage barnlots)	1.0
Service areas (fuel storage, shops, feedlots)	3.0

The term footcandle is the amount of light falling on a surface one foot away from a standard candle. An accurate method of measuring the illumination level on counters, workbenches, etc., is to use a light meter. Borrow a meter from the power supplier representative to help you determine the correct amount of light needed.

There is some security associated with lighted areas where fuel, feed, and seed are stored. In periods of short supplies of fuel, or high-value feeds and seed, it is reassuring to have protective lighting.

Service areas need good lighting and, when it is necessary to refuel and service equipment at night, good lighting is appreciated. At planting and harvest time, it is sometimes necessary to work long hours to get field work done before bad weather arrives. If equipment breaks, it can often be repaired at night in a well lighted area near the shop.

Lighted cattle feedlots provide the following benefits that operators feel generally result in above-average gain:

1) The cattle can feed during a 24-hour period.
2) The timid cattle have a better chance on a 24-hour schedule.
3) The night lighting may eliminate some nervousness by cattle.
4) There is less likelihood of "bunching."
5) In hot weather some cattle feed after dark when temperatures are lower.
6) There are less problems with predators (dog packs, etc.) at night.
7) Cattle can be moved at night with less weight loss.

f. General Wiring

Provision should be made for grounding the non-current carrying metal parts of equipment and wiring devices. The choice of correct wiring materials is essential. When farm buildings are wired with type UF, NMC, or similar cables having a nonmetallic sheath, these cables should include a grounding conductor which must be the same wire size as the current carrying conductors.

Each branch circuit must be protected by its own fuse or circuit breaker. The over-current protective device is selected in accordance with the maximum allowable ampacity (current carrying capacity) of the wire size of the branch circuit. The voltage drop should not exceed 2 percent.

The symbols shown in Appendix D will help you understand the wiring diagrams.

g. Feed preparation centers

Prepared feed is normally fed automatically and sometimes the feed handling routine is a complete cycle from production to harvest, to storage, to preparation, to ultimate feeding or marketing.

The electrical applications in feed handling involve primarily the supply of power for electric motors. In addition, electricity is needed for light and occasionally for heat. The feed preparation center often includes loaders and unloaders, storage facilities, grinders, crushers, roller mills, mixers, conveyors, and sometimes baggers.

Because feed preparation centers vary so greatly in size, it is difficult to present specific plans or recommendations for the electrical systems.

One lighting outlet should be provided for every 150 to 200 square feet of floor area and these lights should be controlled by wall switches. Individual wall switches should be provided for each piece of equipment, such as grinders, roller mills, mixers, and conveyors. Provide dust-tight fixtures because feed handling creates a dusty atmosphere. Provide an outdoor lighting outlet at each entrance and on the side of the building adjacent to outside storage bins.

Provide a 20-ampere duplex receptacle for each 30 linear feet of wall perimeter. Do not plan for these outlets to be used for permanently installed equipment.

Provide individual branch circuits and outlets for each major piece of equipment, such as grinders, blenders, mixers, proportioning equipment, and ventilating fans.

h. Haymows and Lofts

Provide a lighting outlet for each 400 to 500 square feet of mow area. These lights should be controlled by a wall switch that controls the center alley barn lights. Dust-tight fixtures are required in haymows. The lighting outlet may be located near the peak of the roof, allowing six feet of clearance of hay track, or a flood light located high at one end of the haymow. It is desirable to locate these lighting outlets so that hay chutes and ladders are adequately lighted. Be sure fixtures are readily accessible for cleaning and lamp replacement even when the mow is empty. An outside light controlled by a wall switch is needed at the loading-unloading area.

Use symbols shown in Appendix D when planning wiring system.

2. Farm Structures

a. Beef Buildings

In loose housing beef and dairy barns, the principal need for lighting is at feeding and cleaning time. Lighting outlets should be uniformly distributed and spaced at two times their mounting height in open pen areas and 1½ times their mounting height along all feed alleys and troughs. Provide one lighting outlet for each enclosed stall or pen in a loose housing barn. Provide for wall switch control of each section of lights.

Provide a 20-ampere duplex receptacle at each locations where equipment, such as clippers and immersion heaters, may be used. Locate the receptacles about six feet above the floor to minimize damage by animals.

Plan special purpose outlets and individual circuits to serve livestock water heaters at an open pen watering area and a 240-volt circuit to serve the location at which a one horsepower portable motor might be required. Provide a disconnect switch and a grounding type receptacle for the one horsepower 240-volt motor.

b. Swine Buildings

For farrowing houses provide a lighting outlet for each pair of pens. Locate the outlet over the partition and provide wall switches for control. If a center feed alley is used, provide one outlet for every 12 to 15 feet on the center line. Provide at least one outlet for every three sows in farrowing stalls and pens.

Provide at least one 20-ampere duplex outlet for each farrowing pen. An outlet may be needed for a pig brooder and a water warmer. If the climate is such that a water warmer is not required, one outlet may be located to serve two pens. If heating cable is embedded in the floor, provide a 20-ampere circuit for each 1750-watt 120-volt circuit (3500 watt on 240-volt) and plan outlets for thermostat control. A good general rule is to provide for 35 to 40 w. per square foot of floor space. However, it is best to check with the state agricultural college for recommendations for your area. An individual circuit may be needed for feed handling equipment, and another for a gutter cleaner, if one is used.

In swine finishing houses, provide one lighting outlet for each pair of pens or for every 150 square feet of floor area. If a center alley is used, provide outlets every 12 to 15 feet along the center alley, with a row of lights over the pens on each side. Use wall switches for each row of lights and provide 3-way switches for the center row if there are doors in both ends of the building.

Provide a 20-ampere duplex receptacle for every 15 to 20 feet of the alley way. They should be so spaced that an operator can reach any point in the building with a 25-foot extension cord on portable equipment. These should be located at least 5 to 6 feet above the floor level to avoid mechanical damage.

Provide special 20-ampere branch circuits to serve the ventilation fans. In extremely hot weather, the failure of one fan circuit will not stop ventilation if several ventilation circuits are provided. Additional special circuits will be needed for motors on feed-storage bins, feed-conveying systems, barn cleaners, liquid-manure aerators or agitators and a heavy-duty outlet for a large horsepower motor on a liquid-manure pump.

c. Poultry Buildings

Lighting outlets are needed in all types of poultry houses. The application of electricity, other than for lighting, depends on the specific situation.

Heat is vital for broilers. In some circumstances electric heat is used to prevent freezing of drinking water. Ventilation is necessary and is best provided by electric fans with automatic control. In all cases where ventilation is required, it is also recommeded that standby power be available. In the more modern laying house, automatic feeders, manure handling systems, and egg gathering equipment are electrically operated.

In egg handling rooms, electrical outlets must be provided for power fans, refrigeration compressors, water heaters, graders, packers, and washers, as well as for lighting and air conditioning.

In the laying house, lighting and a source of ice-free water are primary considerations. In addition, consideration must be given to electric ventilating fans, automatic feeders, feed handling, manure handling, egg gathering, and in some instances heating equipment. Since practices for lighting vary with the type of poultry (hens, ducks, turkeys), geographic region, and management (morning lighting, morning and evening, special lighting, etc.) it is advisable to contact state colleges of agriculture and power suppliers for specific recommendations. Install one convenience outlet for general use and others for poultry drinking waterers in cold weather. Provide one 20-ampere duplex outlet for every 400 square feet of floor area, and locate them at least three feet above the floor on posts or walls.

d. Dairy Buildings

Lighting outlets in fixed stanchion dairy barns should be over both the feed and litter alleys. In barns where the cows face out, the lighting outlets should be located along the center line of the litter alley, with one outlet directly behind every other stall divider. If fluorescent lamps are used, install a continuous row of two-lamp fixtures along the center of the alley for even lighting of the cows' udders. Where the cows face in, place the lighting outlets about 12 inches to the rear of the gutter and directly behind every other stall divider. The amount of lighting may vary according to the desires of the owner, or it may be prescribed by the requirements of the milk market. Lighting should at least meet the requirements of the latest edition of the National Milk Ordinance Code. Consult with your local power supplier or dairy inspector concerning regional or local regulations.

Convenience outlets may be needed for clippers, electric sprayers, heat lamps, ventilating fans, radio, clock, etc. Provide 20-ampere duplex outlets about 20 feet on center so that an outlet can be reached from any location within the litter alley with a 25 foot cord. The outlets should be located about six feet above the floor to minimize damage by animals. These outlets can be on outside walls where the cows face in, but may be more convenient if located on structural posts if such are available where the cows face out. Determine the type and location for electrical devices and plan the location of the receptacles accordingly.

Special outlets may be needed for the milker, gutter cleaner, hay dryer, bale elevator, refrigeration compressors, vacuum pumps, milk pumps, and feed handling equipment. Provide an outlet at the location of the equipment to be served by an individual branch circuit. Examples are the water heater, feed handling equipment, etc. Outlets for summer ventilation fans and electric window screens may also be needed. Requirements for these outlets are determined by the load to be served. Some of these are 120 volts, other 240 volts. The circuit wire size depends upon the current, voltage, and length of the circuit.

It is sometimes desirable to locate the outdoor lights and haymow lights on the same circuit as center alley lights, so all lights are turned off when the operator leaves the barn. Provide a separate wall switch for each group of lights.

In milking rooms the major requirements for electrical service are for proper heating and lighting. It may be advisable to use waterproof convenience outlets for general purpose use. There is such a wide variety of stall arrangements in milking rooms or parlors that specific recommendations for lighting are not appropriate. It is mandatory that the space be well lighted. A good lighting plan requires one outlet at each animal entrance to the room and a weatherproof wall-switch control for all lighting. If incandenscent lights are used back of the cows (in other than herring bone parlors), place the lighting outlets within one foot of the outer wall and opposite the position of the cows' udders.

Place one weatherproof 20-ampere duplex receptacle at each end of the operator's area. A weatherproof outlet may be required for the waste pump under the pit floor.

If ventilating fans are required by the local dairy inspector, provide an individual circuit and outlet for them. An individual circuit and controls may be needed for the vacuum pump.

Some operators prefer to heat the operator area with heating cable in the pit floor. Others prefer the quick heating overhead infrared lamps, metal-sheath heaters, or quartz tube lamps. Provide for one or more heating circuits and the appropriate controls. After you decide upon the heating means, the location of these circuits may influence the location of the lighting outlets.

A 3500-watt quartz tube lamp located along the center line of the operator's area (one for each ten feet of work space) will provide a satisfactory heat source. A three-wire 120/240 volt circuit should be considered for two or more lamps. For infrared heat lamps, plan for 50 watts per square foot of pit floor area, for pits up to six feet in width. The lamps should be located 7 to 7½ feet above the floor and mounted so as to warm the head, shoulders and back of the operator when attaching milker units to the cow.

If heating cable is to be imbedded in concrete of ramps and unprotected holding pens, for ice and snow melting, install 40-60 watts per square foot.

Provide one or more 120 volt, 20-ampere circuits for auger motors for automatic feeding.

In the milk house, adequate illumination, hot water, and refrigeration equipment are the major requirements for electrical service. Local regulations may require that the vacuum pump be placed outside the milk room. A wall mounted thermostatically controlled heater should be located near the sink area.

The milk house lighting should meet the requirements of the National Milk Ordinance Code, American Society of Agricultural Engineers - Illuminating Engineering Society standards. Lamps must be located to illuminate the bulk milk tank interior, but they must not be directly above the tank due to the breakage problems.

Provide special purpose outlets for the milk cooler. Provide an individual circuit with control for the milk pump of the pipeline milking system, an outlet for water heater, ventilating fan, electric milk pump of the pickup tank truck, portable heater, wash pump, and a water pressure booster pump. The type of outlet required for the milk pump of the pickup truck will depend upon the plug cap used on the cord of the truck. Provide a manual switch adjacent to this outlet for control. Portable heaters may be used in the milk house or if unit-type heaters, ranging from 1500 to 3000 watts are used, they should be operated on 240 volts. These heaters may be overhead infrared lamps, tubes, or quartz lamps.

In some areas toilet facilities are also required at the dairy barns. Electrical outlets in the toilet room should include a lighting outlet over the wash basin with a wall-switch control, a convenience outlet, and a special outlet for a space heater.

It is advisable to provide GFCI protection for the circuits providing current to the convenience outlets in wet areas in fixed stanchion barns, milking rooms, and milk houses because there is considerable danger of electrical shock hazard due to high moisture.

e. Horse Stables

Provide one lighting outlet for every 12 to 15 feet along the center line of the alley. Provide one outlet for each box stall. There should be a wall-switch control for the feed-alley lighting outlet separate from the box stall outlets.

Place the convenience outlet in the feed alley and provide one 20-ampere duplex outlet for each three stalls. These outlets are for clipper, groomers, etc. Provide outlets in the tack room for clock, radio, and leather working or other power tools. You may wish to provide special purpose outlets for an infrared heater for each box stall. Provide an individual branch circuit for ventilation fans, and an outlet for each unit of feed handling equipment, such as an oat crusher, roller mill, conveyor, mixer, etc.

f. Sheep Barn

One lighting outlet is needed for every 12 to 15 feet along the center line of the alley adjacent to lambing or feeding pens. These lights should be controlled by a wall switch.

Provide one 20-ampere duplex outlet for each pair of pens. These outlets are for brooders and heat lamps. Where heat lamps are used, it is suggested that the 20-ampere circuits be limited to seven 250-watt lamps and that the load be distributed on both legs of the 240 volt service.

Outlets should be provided for water warmers located adjacent to the watering troughs. Provide outlets at the wall or post locations where shearing is done and at the major entrance to the sheep barn or lambing shed. Provide an individual branch circuit for ventilating fans. You may wish to provide a circuit for heating cable or heating devices to protect the water supply from freezing.

g. Greenhouses

Special lighting requirements vary with the needs of management for advancing or retarding plant growth so it is advisable to consult special authorities for specific recommendations. For general lighting provide one lighting outlet every 12 feet through the center of the house with wall switches to control these lights. There should be one outlet over each work bench in the head house with a minimum of one outlet for every 5 feet of work bench.

Outlets are needed in the head house for fans, clock, radio, and other uses. Provide one or more individual circuits to serve benches where soil heating cable is used. If a soil sterilizer (pasteurizer) is used it will usually require at least 6 to 8 kw per cubic yard at 240 volts. Provide an individual circuit for portable spray pumps, evaporative coolers, etc.

h. Roadside Stand

Provide one lighting outlet for each 5 feet of bench and for every 50 square feet of display area. There may be a need for outside floodlighting and sign lighting. Plan for at least one circuit to serve a 20-ampere duplex general-use receptacle.

i. Farm Shop

The lighting outlets should be 10 to 12 feet on center. This gives an outlet for every 100 to 150 square feet. Each row of lights should be controlled separately. These should be two lighting outlets for each 10 feet of work bench and they should be controlled by wall switches. Fluorescent fixtures provide continuous lighting over work benches and reflectorized bulbs eliminate the need for cleaning reflective fixtures. One outside light can be controlled by a photo-electric cell.

Provide one 20-ampere duplex outlet for each 5 feet of work bench and one outlet for each motor driven tool. Locate the outlets 48" above the floor. It may be advisable to protect nonmetallic cable with thin wall conduit to prevent physical damage to the conductors.

Provide for a 50-ampere, 3 wire circuit and outlet for an electric welder.

The shop should have some space heating. Infrared lamps, quartz heaters, or heating cable in the floor can provide this.

j. Machinery Sheds

Provide one lighting outlet for each 200-300 square feet of floor area. The lights should be wall switch controlled.

There should be one 20-ampere duplex receptacle for every 40 feet of perimeter wall for use of power tools, trouble lamps, auxiliary heaters, etc.

k. Water System

Provide a special purpose outlet and circuit for each water pump. These circuits should be protected from fire hazards.

It is advisable to have the pump circuits on a separate disconnect from the remainder of the farm wiring. In case of fire, the pump circuit can remain energized while other circuits may be opened. This provides power to the water system for fire fighting purposes. These circuits should be run underground.

In addition to the pump circuit, provide a lighting outlet and convenience outlets near the pump. This provides light and outlets for power tools or heater needed for pump servicing.

Be sure the water pump, motor frame, and switch enclosures are grounded.

3. Specific Requirements

a. Farm Home (Single-Family Dwelling)

1) Lighting load shall be calculated on the basis of 3 watts per square foot of floor area. Floor area is computed from outside dimensions of house, times number of floors, excluding open porches, garages, and unfinished areas.

2) One general lighting circuit shall be provided for each 500 square feet of floor area. Lighting circuits include all lighting outlets and convenience outlets in living bedroom areas.

3) For the small appliance load, including refrigeration equipment, in kitchen, pantry, family room, dining room, and breakfast room of dwelling occupancies, two or more 20-ampere small appliance circuits shall be supplied.

4) Provide a separate circuit for each appliance requiring more than 1500 watts or 12 amperes.

5) It is not a Code requirement that a separate circuit be provided for a waste disposal unit. However, it cannot be supplied from one of the 20-ampere small-appliance circuits since it is a fixed appliance. If it is directly wired without a receptacle, it may be supplied by an individual branch circuit or it may be fed by one of the general purpose lighting and appliance branch circuits provided for in section 220-3(A). If its total rating does not exceed 50% of the branch circuit rating, some inspectors will permit it to be fed by a receptacle on a general purpose circuit just as the outlet in an exhaust fan is permitted. The feeling is that the receptacle (mounted under the sink) is usually inaccessible for general kitchen small appliance use.

6) At least one receptacle outlet shall be installed for the laundry and it shall be placed within 6 feet of the intended location of the appliance.

b. Other Farm Buildings

1) Lighting load for general storage buildings shall be computed at 1/4 watt per square foot, one circuit for each 1500 watts.

2) General convenience outlets shall be computed at 1.5 amps per outlet, or maximum of ten per 15 or 20 amp circuit.

3) Large appliance and motor circuits--separate circuits should be provided for each appliance requiring more than 1500 watts and for each permanently connected motor and all motors larger than ½ hp.

In the sections that follow, there may seem to be some confusion on when you use 120-240 volts and when you use 115-230 volts. In speaking of the two secondary voltages available on the farm, the terms 120 and 240 volts are most acceptable. However, electric motor ratings are at 115 and 230 volts and all problems involving the Code are calculated using 115 and 230 volts.

c. Planning the Size of Branch Circuit Wire

According to the Code, the minimum size of copper wire for general lighting circuits shall be No. 14 and for small appliance circuits, No. 12.

Wire size for individually connected large appliances should be selected according to the rating on the nameplate of the appliance, in the case of appliances other than motors. Example: What size wire should be used to connect a range requiring 12,000 watts? Convert this to amperes.

$$\frac{12{,}000}{230} = 52 + \text{amperes}$$

This calls for No. 6 copper wire which has a capacity of 55 amperes.

In selecting wire for a motor circuit, the Code directs you to use the full load current ratings, unless the motor nameplate rating is higher. The Code further states that branch circuit wiring to a motor shall be large enough to carry 125% of the full-load current, if a single motor is involved. If two or more motors are served by the same branch circuit, it shall have capacity no less than 125% the full-load current of the largest motor plus the actual full-load of each other motor on the circuit.

d. Planning the Size of Entrance Wires

In planning the size of entrance wiring to ordinary outbuildings on the farm, the computed loads of the various branch circuits are added together. The service wires are then determined by consulting a table and selecting a size that has at least the current-carrying capacity needed.

In planning entrance wiring for the farm dwelling, "demand factors" may be applied in some cases. A demand factor of less than 100% of the total computed load is justified because it is assumed that not every light and appliance will be operating at full load at any one time. Entrance wire size may, therefore, be reduced accordingly.

For example, in calculating the combined electrical load for lighting and small appliances, the Code states that a demand factor of 100% must be applied to the first 3,000 watts. All above 3,000 watts may be figured at a demand factor of 35%. Thus, if the lighting and small appliance load is computed to be 5,000 watts, this part of the load may be figured to be only 3,700 watts (3,000 + 35% of 2,000 = 3,700).

Thus, an electric range with a nameplate rating of 12,000 watts is figured at 8 kw or 8,000 watts in determining its share of load on the main entrance.

A wall-mounted oven rated at 5,600 watts plus a counter-mounted cooling unit rated at 5,850 watts would not be figured at 11,450 watts (5,600 + 5,850) but at 65% of this figure, or 7,443 watts. A 65% demand factor is used for 2 appliances with individual ratings between 3½ and 8 3/4 kw.

In computing space heating and air cooling loads, only the larger of the two loads is calculated as it is assumed that both will not be operating at the same time.

For fixed appliances other than ranges, air conditioners, or space heating equipment, nameplate ratings are added together unless 4 or more of these appliances are connected. Then a 75% demand factor may be applied. Appliances, such as water heaters, washers, clothes dryers, and dish washers, are of this type.

In addition to the above, the Code states that, if the computed load for a home equals or exceeds 10,000 watts, a minimum of a 100-ampere entrance shall be provided. This is true even though 10,000 ÷ 230 equals only about 43.5 amperes.

e. Planning the Size of Outdoor Feeder Wires

The minimum size feeders, or the overhead wires running from the load center to each building, may be determined by any one of three factors. They are: (1) mechanical strength, (2) ampacity, and (3) voltage drop.

1) Mechanical strength is important because of the hazard involved if wires break and fall down when loaded with ice or blown by the wind. The Code states that if the length of unsupported span is less than 50 feet, conductors must be No. 10 or larger. If the span is greater than 50 feet, they must be No. 8 or larger. This is a very simple rule to interpret and apply.

2) Ampacity refers to the safe limit of current in amperes that a given wire can conduct. This limit is higher for a single conductor in free air than for the same size wire in cable or conduit.

3) Voltage drop is more difficult to comprehend and to calculate but is very important if satisfactory results are to be obtained. Voltage drop is usually the factor that determines the size of overhead feeders because of the distances involved in farm wiring. The effect of length of wire on voltage drop is comparable to the effect of length of pipe on water pressure. At 40 pounds per square inch (psi), a ½-inch pipe might carry enough water for an automatic hog waterer if it is only 20 feet from the supply tank. If we try to use the same size pipe to carry water out to the hogs on pasture 1,000 feet or more away from the supply tank, it will be entirely too small. This is due to pressure drop caused by friction in the pipe. Similarly, there is a pressure drop, or voltage drop, when current is carried long distances on wires.

According to the Code, the size of feeder conductors should be such that voltage drop up to the final distribution point will be not more than 3 percent for power or heating loads, and not more than 1 percent for lighting loads or combined lighting, heating, and power loads. Even though lighting is involved in all farm builidings, we shall consider a 3 percent voltage drop as a practical maximum. To carry 55 amperes a distance of 500 feet at 240 volts with not over a 3 percent voltage drop, No. 0 wire would be required.

You may calculate the size of copper wire necessary to prevent excessive voltage drop by using the following formula:

$$\frac{22^{*} \text{ x amps x distance (ft. one way)}}{\text{volts drop permitted}} = \begin{array}{l}\text{circular mils}\\ \text{(cross-section}\\ \text{of wire)}\end{array}$$

*22 is a figure that remains constant for 60-Hertz alternating current.

You generally know all of these figures but one and can solve for that one figure. For example, the load, distance, and voltage drop (3% of 115 or 230) may be known and you will solve for size of wire in circular mils. In another case you might have the wire already installed and want to know how many amperes could be carried without causing a voltage drop of more than 3%. You would, therefore, fill in circular mils, distance, and voltage drop and solve for amperes.

M. Emergency Power Supply

1. Electrical power is essential on most farms. A power failure can have serious consequences. Uninterrupted electrical service has become essential on most mechanized farm operations. Many farm appliances, such as milk coolers, water pumps, furnaces, and ventilating equipment, require continuous electrical power. Total confinement poultry buildings with electric incubators, brooders, and ventilating equipment require continuous electrical service. Greenhouse operations, where the heating system depends upon electrical equipment, and large dairy farms, where water cannot be pumped by hand and labor is not available for milking, require continuous electrical service.

2. Power failures do occur from storms, accidents, and equipment falling on the lines to cause service interruptions. With major natural disasters, such as tornadoes, blizzards, floods, and ice storms, power outages can last from several hours to over a month. In the event of power failure, every home and every farm is affected in varying degrees. With standby electric service, a farmer can keep his power equipment operating during the power outages and avoid both inconvenience and possible financial loss. Since power failures do occur, standby equipment may be needed to provide electricity in an emergency.

3. Standby equipment must be connected to the farm wiring system by means of a double-throw switch which will disconnect the power supplier's service before the generator is connected. There are two important reasons for this requirement. First, this will prevent feeding power back into the supplier's line and, thus, endangering the lives of linemen. Secondly, it prevents damage to the generator by feeding power back into it when normal electrical service is restored.

The capacity of the double-throw switch must be matched to the rating of the conductors supplying the load from the normal source of current and not to the rating of the generator or to the load when the generator is in operation.

Standby generating equipment is of two general types, engine-driven and tractor-driven units. The engine-driven units can be further classified into automatic and non-automatic types.

4. An automatic standby generator is driven by an engine that starts automatically in case of a power failure. The capacity of these units (10 kilowatt or larger) is generally greater than that of the non-automatic units. A double-throw magnetic switch normally energizes the farm wiring system from the power supplier's line. In case of power interruption, the engine is automatically started. When it is up to speed the farm wiring system is transferred to it automatically.

   For most farms a manually started, non-automatic unit will be equally satisfactory and much less expensive. A "power-off" alarm is used to warn the operator of the power failure. These alarms are available with both audible and visual indicators.

5. A non-automatic standby generator is driven by a manually started engine. This type of system is suitable where automatic operation is not needed and where a tractor is not available to drive the generator. This system is less expensive than the automatic system. The advantage over a tractor driven unit is that it is not necessary to line up belts and pulleys or the tractor power take-off before the system can be operated. One warning, however, is that such an engine should be started frequently, to make sure it will run when needed.

6. On many farms, a tractor-driven generator, operated by either power take-off or belt, has proven satisfactory. Generators with 540 and 1000 rpm input are available. A special generator unit may be mounted on a tractor or on a trailer. The tractor power generator is much less expensive than the complete engine generator unit. Usually the tractor is kept in good running condition and it would be ready to drive the generator.

7. The electrical characteristics of the generator must be suited to the load. Usually, this will require a 60-Hertz unit producing power to operate 120/240v equipment. The actual rating of the standby generator may be 110/220, 115/230, 120/240, or 120/208 volts. This depends upon the system and the rating used. A generator with any one of these ratings will successfully provide power to a 120/240 volt farm load, provided it is of the proper size. The capacity of the generator must be suited to the maximum load to be carried, and should be approximately 3 times the ampere rating of the largest motor to be started, so as to allow for the starting current of the motor, unless the generator is especially designed for motor-starting duty.

8. Be sure to follow the manufacturer's requirements for engine capacity to run the generator or be sure the tractor will operate a particular generator. The horsepower supplied by the engine or tractor should be at least twice the kilowatt rating of the generator--that is, a 20 horsepower tractor to drive a 10 kilowatt generator. The operator must decide which equipment must be operated and which is nonessential. Then, he may need to stagger the operation of essential equipment to keep within the capacity of the generator.

   Some manufacturers have centered tap delta systems available that can be used with single-phase, three-phase, or for split entrances with no sacrifice in load. This type of unit would prevent obsolencence if the farm was changed from single-phase to three-phase service.

   The generator may be connected to serve an entire farm, a single building, or an individual branch circuit. Detailed connection diagrams are available from your power supplier.

N. Selecting Wiring Materials

There are many choices of wiring materials and supplies that you must make as you plan the wiring system, such as type of wire and gauge, fuses vs. circuit breakers, outlet boxes based on their location and capacity, and receptacles based on the load.

1. Wires and cables

There are many types of wires and cables available for farm wiring. Some are suitable for outdoor use, some underground, some for indoor use, and some for either indoor or outdoor installation.

a. Outdoor wire was formerly called "weather-proof" in the Code. This may be a single wire of copper or aluminum, and is usually covered with neoprene or polyethylene. In recent years, a three-conductor, self-supporting service drop wire has become common. This consists of two insulated wires wrapped around a bare stranded wire, which is used as the neutral conductor and also is the supporting wire. This three-conductor service drop is generally aluminum, although the bare wire usually has one galvanized steel strand to add strength. Outdoor wire is stretched across open spans between buildings or poles and is supported on insulators, usually made of porcelain.

b. Underground wire has become increasingly popular in recent years due to the development of new insulating materials and the availability of power equipment for digging trenches. When underground wires are used, there are no service interruptions due to ice storms, no danger from fallen wires, and no problems of striking overhead wires with farm equipment. Using an underground distribution system makes a more attractive farmstead by eliminating the network of overhead wires radiating from the load center.

Underground wire is designated in the Code as Type UF (underground feeder) or Type USE (underground service entrance) and may be available either as single wires or as cables of two or three wires. These types of wire and cable may be buried directly in the earth with mechanical protection required only where they enter and leave the earth.

c. Indoor wire is designed for use inside buildings, either as single wires inside conduit or as cables. Indoor wire is insulated with some approved material that will withstand voltage considerably higher than the normal secondary farm voltages. Most of these insulating materials are approved for voltages up to 600.

Years ago, most indoor wire used on the farm was rubber-covered. This has been largely replaced today by wire insulated with a single layer of thermoplastic material. Thermoplastic insulation is less bulky than rubber, more resistant to moisture and light, and easier to remove when making connections. Ordinary thermoplastic wire is designated in the Code as Type T while a moisture resistant thermoplastic is called Type TW.

Some special types of rubber-covered wire are in common use today for service entrances, particularly in the larger sizes. They are Type RH, heat resistant rubber. They are approved by the Code for carrying higher currents than the same sizes of thermoplastic-insulated wire.

Indoor wire is colored for identification purposes. Standard colors of insulation are white, black, and red, although for conduit wiring, it may be obtained in several other colors.

Heat-resistant thermoplastic wire, used in dry locations, is designated as THHN. It is smaller than TW. The area of a single #12 conductor is .0117 sq. in. as compared to .0278 sq. in. for TW. Tables 3A and 3B in the Code show that 10 No. 12 THHN conductors can be in 1/2 conduit as compared to 7 No. 12 TW insulated conductors.

d. Service-entrance cable is designed for bringing current into buildings although it is also used indoors to connect large appliances like ovens, ranges, large motors, and welders. Service-entrance cable, Type SE, is made up of one or more insulated wires covered by a spiral winding of fine stranded bare wire. Over the bare wire is a covering of fabric which is treated with a water proofing material to make the cable suitable for use on a pole or on the outside of a building exposed to the weather.

In practice, the spiral winding of bare wire is twisted to form the neutral or grounded conductor in the circuit. It usually makes a wire of the same size as the insulated wires, although sometimes it is one size smaller.

Nonmetallic cables are used for most inside wiring in farm houses and outbuildings. Nonmetallic cable is easy to install, is economical in price, and is entirely satisfactory if the right type is used for a given location.

Type NM, formerly contained individual wires, usually thermoplastic insulated, wrapped with paper, and enclosed in a fabric braid that was saturated with moisture and fire resistant material. A new kind of NM cable has a plastic outer covering and is preferred to the braid covered cable because of easier handling and neater appearing finished work. The plastic covered cable is available with two or three conductors, and with or without an uninsulated or bare conductor for grounding purposes. The bare grounding conductor was formerly smaller than the current conductors but in recent years is the same gauge as the other conductors. This applies to Nos. 14, 12, and 10 wire. Type NM is suitable for both exposed and concealed work in normally dry locations.

Type UF, underground feeder and branch circuit cable, is an excellent material to use in outbuildings on the farm as it is approved for wet locations and may be less expensive than Type NMC. It has special water-proof insulation and covering of plastic and is available with two or three insulated conductors and with or without a bare conductor for grounding purposes. As mentioned previously, UF is also approved for direct burial in the earth if it is properly protected with fuses or circuit breakers rated according to the ampacity of the wire.

Cables carry distinctive markings on the exterior covering clearly specifying the type. Some plastic covered NM cable is very similar in appearance to UF cable. Carefully examine the markings on the exterior covering to be certain you are using the correct type.

e. Aluminum conductors have become popular because of the increased cost of copper. At least one manufacturer has copper clad aluminum conductors available.

There have been reports of failure of aluminum conductors but these can be traced to one or more of the following causes:

1) Poor workmanship and installation techniques
2) Excessive vibration or mechanical disturbances
3) High humidity
4) Wide temperature changes
5) Incompatible connections between aluminum conductors and terminals on the devices

Underwriter's Laboratories have tested these conductors and the manufacturers now include instructions on the proper installation techniques and practices with each coil of No. 12 or 10 AWG insulated wire or cable.

When purchasing devices (receptacles and switches) for use with aluminum conductors, be sure they are marked "CO/ALR." If devices have no conductor marking, screwless or push-in connections, back wired terminals, or if they are marked "Al-Cu," then aluminum or copper-clad conductors should not be used.

Electrical contractors of residential construction who have used copper-clad aluminum conductors feel that it has some advantages:

1) The better flexibility of aluminum offsets the inconvenience of the larger wire size
2) Reliable connections can be made with new devices and appliances
3) The two kitchen small appliance circuits were wired with No. 12 copper and all other circuits were wired with No. 12 copper-clad aluminum. The uniform wire size made it convenient to use uniform sized boxes and connectors
4) Reduced pilferage is an advantage because there is little scrap value to copper-clad aluminum
5) The lighter weight made it easier to handle long coils of wire

f. Size of wire is an imporatnt factor to consider in selection. Just as a large pipe will carry more water than a small one at a given pressure, so a large wire will carry more current than a small one at a given voltage. If we attempt to force a large current over a small wire, the voltage will be reduced because of excessive resistance and the electrical appliance will not function properly. Also, the excessive current will cause the wire to heat up, perhaps to the danger point.

Electric wires are given a number to indicate their size or gauge according to American Wire Gauge (AWG) standards. Small numbers indicate large wires while large numbers mean small wires. Thus, a No. 14 wire is smaller than a No. 12 and a No. 14 is larger than a No. 6.

Since most wires are round, the unit used to measure the cross-sectional area of a wire is the circular mil. A circular mil is the area of a circle whose diameter is one mil or .001 inch. Since the area of a circle is proportional to the square of its diameter, a wire two mils in diameter will have four times the cross-sectional area of a wire one mil in diameter. Resistance is inversely proportional to cross-sectional area so if the cross-sectional area is cut in half, resistance is doubled.

Wires may be either solid or stranded. Stranded wire is made up of several small wires wrapped together to give more flexibility, particularly to the larger sizes of wire. Indoor wire larger than No. 10 or No. 8 is almost always stranded. A No. 6 stranded conductor, for example, is made up of 7 smaller wires whose total cross-section area is the same as that of a No. 6 solid conductor.

2. Insulators and Wire Supports

Insulators for supporting outdoor wire in overhead spans should be of good quality. Insulator racks are generally preferred for long spans as they can be bolted or fastened securely in place with lag screws. Screw knobs are satisfactory where only a medium amount of tension is expected.

If self-supporting service drop conductors are used as feeders from the load center, use a wedge clamp to hold the neutral conductor or messenger wire. The wedge clamp is attached to a single insulator.

3. Service-Entrance Equipment

a. Entrance caps or heads are used to protect the exposed end of the conduit or entrance cable used to bring current into a building or meter enclosure. Their chief purpose is to keep rain from entering the conduit or cable sheath and possible shorting out of the wires.

b. An entrance elbow may be used where conduit enters a building. The entrance has a removable cover to aid in installing the wires. It permits a square corner to be made with conduit. A sill plate fits around the entrance cable where it turns into a hole in the building finish. A waterproofing compound is used to seal behind the sill plate to prevent water from entering the building through the hole for the entrance cable.

c. An entrance box is necessary to control all electricity in the building. The entrance switch generally provides a means to disconnect the current and contains some kind of overcurrent protection devices for the branch circuits inside the building. These protection devices may be either fuses or circuit breakers.

d. Fuses have been used for many years for overcurrent protection. They are of two basic types--cartridge and plug. Standard fuses contain a link made on a low-melting alloy which is designed to carry current up to the rating of the fuse. A current higher than this ampere rating causes the link to heat above its melting point. When a fuse "blows", the link melts and interrupts the circuit. Most fuses are made for one-time use, although some larger cartridge fuses have replaceable links that may be used in the main body when the fuse blows.

e. Cartridge fuses are made in specified case sizes: 30, 60, 100, 200, 400, and up to 6000 amperes. Each case is designed to accomodate a maximum size fuse link as well as a specific number of smaller size links. A 60-ampere fuse case can accomodate 35,40, 45, 50, or 60 ampere fuse links. A renewable fuse is constructed with threaded end caps that permit removal of a blown internal fusible element and installation of a new one. Knife-type cartridge fuses take from 70 to 600 amperes.

f. Plug fuses are available in three types. The standard plug fuse has an internal fusible link. Time-delay fuses are made to stand a temporary overload, such as may exist while a motor is starting, but will still protect the circuit as a standard fuse if the overload continues. One type of time-delay fuse has one end of the fuse link embedded in solder with a small spring attached to it. A continued overload will melt the solder so the spring can pull the fuse link out, interrupting the circuit. A short circuit will melt the fuse link just like a standard fuse. By examining a blown time-delay fuse, you can usually tell whether the trouble was an overload or a short circuit.

g. A special type of time-delay fuse is the nontamperable fuse. Each size of nontamperable fuse has a different size base and requires a special adapter that is screwed into the standard fuse socket. Once an adapter is installed, it cannot be removed. Thus, if you wish to protect a given circuit with a 15-amp fuse, you can insert a 15-amp adapter and from then on only nontamperable fuses of 15-ampere or smaller capacity can be used.

h. Another type of device is shaped like a fuse and has a reset button. These will fit in a fuse holder but are more like circuit breakers, since the link does not melt.

The advantages of fuses as protective devices include the following:

1) There are no moving parts
2) They are faster. The time required to open a fuse circuit is usually less than any other protective device
3) They are reliable. A given cross section of metal will melt at a given temperature
4) They are not affected by age
5) They are not affected by lack of maintenance
6) They are economical

i. Circuit breakers are being used widely to replace fuses today, particularly in homes. A circuit-breaker box may be somewhat more expensive than a fuse box. However, there is no cost involved in resetting the breakers as there is in replacing fuses.

Circuit breakers may be the thermal or magnetic type. The thermal breaker has two contacts that are held together by a bimetal latch. If the current flow through the breaker is greater than it is rated for, the bimetal strip heats up, releases the latch, and the points spring open, interrupting the circuit. Service can be restored after the bimetal strip cools by resetting the toggle. This is frequently done my moving it to the "off" position and then to "on."

j. The magnetic breaker has contacts that are held together by a latch which is released by the action of an electromagnet. The strength of this electromagnet is determined by the amount of current flowing through the breakers. A current higher than the rating of the breaker creates magnetic pull sufficient to trip the latch. This type breaker is reset merely by moving the toggle to "on."

It is unsatisfactory and frustrating to have a circuit breaker trip when it is loaded within its correct rating. Generally, this is due to the heat developed from loose or corroded connections and this heat is conducted to the sensitive elements of the breaker. This heat may come from conductor connections that are removed from the breaker several inches. If the breaker terminals are not firm or do not make a positive connection where they plug into the distribution panel, these have an immediate effect of developing heat. Regular examination can locate these faults because heat can be easily detected.

A few circuit breakers have failed to open when overloaded and some have even failed to open when the circuit has a short-circuit.

If breakers fail to trip, the parts have usually become sticky. These parts include hinges and actuating mechanisms and sometimes contacts that have "welded" together. Welded contacts sometimes occur following repeated short circuiting.

Nearly all forms of sticking may be remedied by exercising the circuit breaker. A good practice would be to manually operate the breakers through a half-dozen opening and closing cycles about twice a year. This procedure should be considered for all sizes of breakers from 15-ampere circuit protectors to large service-type breakers.

4. Conduit

Conduit (pipe or tubing for electrical wiring) is used more extensively in commercial buildings than for farm wiring. However, it is important in many areas as enclosure for entrance wires and in locations where wires need extra protection from mechanical damage. Conduit is available in various types: rigid, thinwall, flexible, and liquidtight flexible.

a. Rigid conduit resembles galvanized water pipe, except that it is somewhat softer and easier to bend, is inspected more closely for inside smoothness, and comes in 10-foot rather than 21-foot lengths. Rigid conduit is available in the same trade sizes as water pipe from 1/2 inch up. It may be cut, reamed, and threaded with standard pipe tools.

Rigid conduit is fastened to boxes by means of locknuts and bushings. The bushing is screwed on the end of the conduit inside the box to provide a smooth opening that will not damage the insulation on the wires as they are pulled in. The locknut is on the outside with its sharp corners toward the box so that, when tightened, it makes an electrical contact between the conduit and the box for grounding purposes.

b. Thinwall conduit, also called electric metallic tubing (EMT), is not threaded but is coupled together and fastened to boxes with special pressure-type fittings. Couplings join two pieces of thinwall conduit together while connectors are used to join the conduit to boxes. A locknut is used on the connector inside the box so no bushing is necessary.

Thinwall conduit is available in the same inside diameters as rigid except that it is not generally made large than 2 inch. Thinwall conduit is generally preferred for indoor installations because it is easier to cut, bend, and join than rigid. Rigid conduit is better for outdoor use because it is heavier and will last longer.

c. Flexible metal conduit must be installed with special fittings approved for the purpose. This conduit is often used to protect conductors leading to motors where vibration prevents the use of EMT tubing or rigid conduit.

d. Liquidtight flexible metal conduit may be used in locations that require flexibility and protection from liquids, vapors, or solids. This conduit will not withstand physical damage. The flexible metal conduit must be used with special terminal fittings. This conduit may be used for grounding in sizes less than 1¼" if the length is less than six feet and approved fittings are used.

5. Outlet and Switch Boxes

Outlet and switch boxes are used at many points in the wiring system of a building. In fact, except for surface wiring where certain approved nonmetallic devices are used, a box of some kind is installed at every switch, light, or junction point where wires are attached or spliced.

Outlet boxes are usually octagonal (eight-sided) or square. Switch boxes are made for flush mounting or surface mounting.

a. Octagon boxes are usually made of galvanized steel and are normally 4 inches in diameter and 1½ inches deep. They are available with cable clamps, or with knockouts that may be removed for inserting cable connectors or conduits.

b. Square boxes are generally 4 inches across and 1½ inches deep. They are often used in place of octagon boxes where more wires are needed than would be permitted in an octagon box. Square boxes are also available with or without cable clamps.

c. Extension rings are available for both octagon and square boxes. These provide additional room where more wires are needed than are permitted in a single box. The extension ring is shaped like the box it fits on except that it has no bottom.

d. Flush-mounted switch boxes are used in the home or in any finished building where you wish to conceal the wiring in the walls. These boxes are available in a variety of types and depths. Most common are the beveled corner switch boxes with clamps for nonmetallic cable, and the square corner boxes with or without cable clamps. Flush mounted switch boxes are available with side brackets to facilitate nailing to wall studs. These boxes are sometimes called "new work" boxes.

The sides of most flush-mounted switch boxes are removable so that two or more boxes can be ganged together to provide for a series of switches or receptacles at one location.

e. Surface-mounted switch boxes or handy boxes are made for fastening to an exposed surface and are widely used in outbuildings on the farm. They have rounded corners and are generally not equipped with cable clamps. They can be used for conduit or cable wiring, but if nonmetallic cables are used they should be the type that has a bare grounding wire. This bare wire is used to ground the boxes.

f. Number of wires of various sizes permitted in boxes is specified by the Code. This is done to limit the hazard of damage to the wires if too many are forced into a box.

These numbers apply where no fittings or devices, such as fixture studs, cable clamps, hickeys, switches, or receptacles are contained in the box and where no grounding conductors are part of the wiring of the box.

If the box contains one or more fixture studs, cable clamps or hickeys, the number of conductors shall be one less than shown in the table. If a flush switch or receptacle is contained in the box, the number of conductors will be further reduced by one. A conductor running through the box without splice is counted as one. Each wire terminating in the box is counted as one. One or more grounding conductors are counted as one conductor.

6. Porcelain lampholders

Common porcelain lampholders, made to fit on 4-inch octagon boxes, are of two types--keyless and pull-chain. The keyless lampholder is controlled by a separate switch in the line. The pull-chain lampholder has a built-in switch and may or may not have a single plug-in receptable in its base.

7. Switches

Toggle switches are used to control lights and other outlets. They may be single-pole, three-way, or four-way types. These differ in number of terminals and in the number of places from which they can control lights.

a. Single-pole switches are used to make and break the connection in a single wire. They, therefore, have only two terminal screws and are used to control lights from one location. Single-pole switches are indicating; that is, you can tell by looking at them whether they are turn "on" or "off." They most common indication is the word "on" or "off" that shows on the toggle.

b. Three-way switches have three terminals and are used in pairs to control lights from two different locations. Three-way switches are not indicating so there is no marking on the toggle.

c. Four-way switches have four terminal screws and are used in combination with a pair of three-ways to control lights from three or more locations. One four-way and two three-ways will provide control from three places; two four-ways and two three-ways give four control locations, etc. Four-way switches are also nonindicating.

Switches are rated according to their safe ampere carrying capacity. However, the ordinary toggle switch is approved by the Code to carry only half its rating in incandescent lights. A tungsten filament bulb has low resistance when it is cold and normal resistance when it is hot. Thus, a high current flows in an incandescent light circuit for a brief instant when it is first turned "on." The rating of the switch can be found on the strap. If the marking says "10A125V - 5A250V", it means 10 amperes at 125 volts or 5 amperes at 250 volts.

Switches that are T-shaped are approved for carrying their full rated load even in incandescent lights. These high-quality switches have the letter "T" before or after their ampere rating on the strap. T-rated switches are required by some local codes and are always recommended because of their longer life.

8. Duplex Receptacles

Duplex receptacles are double plug-in outlets which are installed in switch boxes, handy boxes, octagon boxes, or square boxes. Each receptacle has two pairs of terminal screws--one pair for connecting the line-in and the other pair for wires leading on to another receptacle or other device in the circuit. This avoids the necessity of splicing wires. Some receptacles have a "pry out" connection on the "hot" side which can be removed in case you wish to control each individual plug-in separately.

Grounding-type duplex receptacles have additional green-colored terminals for attaching grounding wires. They also have D-shaped openings in addition to the parallel slots to accomodate standard three-prong plugs, such as are found on portable power tools and appliances. The Code now requires that grounding-type receptacles be installed for all 15- and 20-ampere branch circuits. This is an important safety factor and the Code (250-45) requires that exposed noncurrent-carrying metal parts of cord and plug-connected equipment that is liable to become energized, shall be grounded. This includes refrigerators, freezers, air conditioners, clothes washing and drying and dish washing machines, sump pumps, and portable, hand-held, motor-operated tools and appliances used in residences. In other locations, all cord connected appliances shall be grounded that are used in damp or wet locations or by persons standing on the ground or in metal grain bins or in wet or conductive areas.

Self-grounding receptacles are available that have a special pressure clip to insure tight contact between the screws and the mounting strap. The use of grounding receptacles requires cable having a bare grounding wire which is connected to the green terminals, unless a conduit wiring system is used. If a conduit system is properly grounded and the receptacle is mechanically connected securely to the box by the mounting bracket, the receptacle is considered to be satisfactorily grounded.

9. Other Receptacles and Combinations

   a. 240-volt receptacles are available for various purposes. The single receptacle with tandem slots and a U-shaped ground is for 240-volt equipment using 15 amperes or less. The 3-slot receptacle for "crow-foot" plugs is for 240-volt equipment using 20 amperes or less. Both of these types may be installed in standard switch or handy boxes.

The one with the L-shaped ground is often used for clothes dryers and is suitable for loads up to 30 amperes. The other is a standard range receptacle and is suitable for loads up to 50 amperes.

b. A combination switch and receptacle may be used when you wish to have a convenience outlet in the same switch or handy box with a switch. Usually, they are connected so the outlet is "hot" all the time and the switch controls one or more lights in the room or building. However, they can be connected so the switch controls the outlet.

c. A fuse and receptacle may also be obtained in combination. This device, which is mounted on a switch or handy box, usually has a single grounding receptacle and a fuse holder. A fuse is selected which is of the proper size and type to protect the device that is plugged into this outlet. A sump pump is an example of a device that can be conveniently protected in this manner.

10. Wall Plates and Box Covers

Switch, duplex receptacle, and combination plates are available in bakelite, metal, glass, and other materials. These are used for flush wiring, chiefly in the house. Bakelite plates in ivory or brown are most common.

Multiple gang plates are used where switch boxes have been ganged together. Plates for various combinations of switches and receptacles are available.

Surface-mounted boxes require covers instead of wall plates. Blank covers are used on octagon, square, or handy boxes that are simple junction points. Switch and receptacle covers for handy boxes are also available in metal and bakelite.

11. Nonmetallic Surface-Wiring Devices

Special fittings made of bakelite are available which are completely shockproof and take the place of metal boxes, switches, outlets, etc. Common devices used are duplex receptacles, keyless lampholders, pull lampholders, single-pole switches, and three-way switches. Each device acts as a junction box for as many as four cables in addition to performing its special function. Terminal screws are provided for making all connections and splices so no special splicing devices or tape are required. Only short wire ends are used so there is some saving in wire when these devices are used.

These devices are suitable only for surface wiring. However, most of the wiring on the farm, except in the house, is done on the surface so they have considerable application. In addition to being shockproof, they are also corrosion-proof so are quite suitable for damp locations, such as animal shelters and fertilizer and chemical storage buildings.

12. Remote-Control Systems

Low-voltage, electromagnet-operated controls are available for farm yardlights or for complete interior wiring systems. They use a small transformer to produce a low-voltage current that is used for switching only. The switches that are used with this system are usually momentary contact type. A 120-volt relay switch is installed in or near the light fixture. It is turned on and off by the action of a small electromagnet which is energized to operate in one direction or the other by pressing one of the momentary contact switches.

A remote-control yardlight unit can be mounted on a yard pole or on any farm building near where the feeder wires are attached. The unit is connected directly to the 120-volt line. Three small wires are then run to every desired switch location. No. 18 or 19 thermoplastic 3-wire cable can be strung overhead in spans up to 150 feet or buried in the earth. This wire requires no special protection inside buildings. It can be stapled to the surface with insulating staples, such as are used for door chime or thermostat circuits, or it can be fished loose in the walls.

The chief advantage of a remote-control system is that any desired number of switch locations can be provided at very low cost after the main control unit has been purchased. The system is generally less costly than a conventional yardlight system if control from three or more places is desired, or if the distance between two switch locations is long.

If a remote-control system is used in the home, each room is usually provided with a switch at each door. Control for every light in the house is frequently provided in the master bedroom.

13. Miscellaneous Materials

a. Cable connectors are used to fasten cables to boxes that do not have built-in cable clamps. Connectors for ordinary nonmetallic cable fit in a ½-inch knockout opening. Connectors that require a 3/4-inch or 1-inch opening are used for service entrance cable. These may be non-watertight for indoor use but must be watertight when used outdoors for entering meter enclosures or raintight switch boxes.

b. Split-bolt connectors are very convenient for connecting outdoor wires to entrance wires. They are available in sizes to fit the largest wires. Split-bolt connectors for joining two or more copper wires are made of copper or brass. Connectors used to join copper to aluminum have a special coating to prevent galvanic corrosion and a coated spacer should be placed between the conductors.

c. Solderless connectors have received wide acceptance in making approved splices. In the past most connections were made by soldering and taping but various styles of solderless connectors have largely replaced solder. Some solderless connectors have insulating caps while others must have an insulating cover or tape put over the connection.

Several kinds of approved solderless connectors are available for joining wires inside junction boxes. One type has a thimble-shaped nylon or plastic cap containing a tensioned coil spring. As this connector is twisted on, the spring tension inside the coil is relaxed. When the twisting action stops, the tension of the spring grips the wires tightly.

Of the bakelite types one has coil spring threads inside the cap which are turned onto the pigtail connection to make and insulate it in one operation. The other has a brass sleeve with a set screw for tightening onto the connection. The bakelite cap threads onto this sleeve to insulate the connection. After this connector is twisted onto the splice, the straight piece is broken off and the connection is covered with tape or a special plastic boot.

All of these solderless connectors are made in a variety of sizes for joining various numbers and combinations of sizes of wires. Manufacturers' recommendations should be followed in selecting the right size for the job to be done, and in stripping and twisting conductors.

New self stripping tap connectors make it easy to connect a pigtail splice to a receptacle.

Straps or staples are used to fasten conduits and cables to the surfaces over which they run.

d. Box hangers are useful in mounting outlet boxes, particularly in new work.

e. Knockout seals are available to close unused openings where knockouts have been removed. They snap into place to keep mice, dirt, and trash away from the wires.

f. Grounding screws, clips, and pigtails are used to connect grounding conductors to boxes. If the box has a tapped hole, grounding screws or screws and pigtails can be used. If the older boxes do not have tapped holes, special grounding clips can be used to ground the box.

Ground rods and clamps are important items in farm wiring. Recommended rods are copper, or copper-covered steel, 5/8 inch in diameter and 8 feet long. A bronze clamp is made to attach a ground wire to this type of rod.

In planning the farm wiring system, consider first the general requiremtns for each of the major farm buildings. Then consider the specific requirements that will determine the size and number of branch circuits, the size of entrance equipment, the size of feeder wires, and eventually the size of main farm service entrance.

O. Electrical Service

Electric current may be brought to a building from the meter pole or load center on overhead or underground wires. In the past most outdoor runs of wire have been overhead. The development of new insulating coverings in recent years has made the use of underground wiring more feasible, and hence it is being used to a considerable extent today.

1. Installing Insulators for Overhead Wires

When installing overhead wires, use good quality insulators and be sure they are securely attached to the pole at the load center and to the various farm buildings. Insulators may be of different types including insulator racks, screw knobs, and swinging clevis types.

Insulator racks are generally preferred for long spans or with large wires where a great amount of tension is expected. Insulator racks can be bolted in place or mounted with lag screws. For lag screws, drill a pilot hole that is as large as the shank of the lag screw and as deep as the length of the shank. Continue the hole using a bit slightly smaller than the root diameter of the screw (threaded part without the threads). Tighten lag screws with a wrench. Do not drive them in with a hammer as this shreds the wood fibers and reduces the holding power of the screw threads.

a. Swinging clevis type insulators are frequently used to support the three-strand outdoor wire that has two insulated conductors wound around one bare "messenger" wire. The clevis which holds the single insulator can be fastened with clamps to the service conduit. It can be fastened to a building or pole with a bolt or lag screw.

b. Screw knobs are satisfactory for short spans or with smaller sizes of outdoor wire and are somewhat less expensive than racks. A screw knob has a threaded point like a lag screw and should be turned into a pilot hole, particularly in new wood or in hard wood. Insert a heavy screwdriver or the handle of your lineman's pliers into the screw knob to tighten it securely. Take care to avoid cracking the porcelain insulator.

When attaching an insulator rack, screw knob, or clevis to a building, be sure it is fastened to a structural member (at least two-inch lumber) rather than to a covering board. It may be necessary to place a special piece of framing lumber in a farm building so the insulators may be mounted securely where you want them.

Insulators should be placed at a height so that overhead wires will have a minimum clearance of 18 feet over driveways and at least 10 feet over other parts of the farmstead. The Code states, "Conductors shall have a clearance of not less than 36 inches from windows, doors, porches, fire escapes, and similar locations. Conductors run above the top level of a window are considered out of reach from that window." Wires should not run closer than 3 feet from a window unless they are above the window.

2. Unrolling and Fastening Outdoor Wires

Outdoor wire is usually unrolled and cut to length on the ground, allowing three or four feet at each end for fastening to insulators. When unrolling wire, be sure that the spirals created by winding the roll are removed so the wire will not be twisted or kinked when it is pulled up tight. One method of removing the spirals is to withdraw the wire from the center of the roll, whipping the wire to unwind the spirals as they are withdrawn. Another method is to anchor the end of the outer winding and carry the roll in one arm while paying off four or five outer spirals. Then shift the roll to the other arm and count off the same number of turns in the opposite direction. Repeat this as necessary to cover the distance.

If the wire is No. 8 or smaller, run the end through the insulator twice. Give the wire a good wrap, going around three or four times up close to the insulator. Then, wind out a spiral and finish with three or four more close turns. It is generally preferable to leave the end a foot long or more so connection can be made to the service entrance conductor.

It is not convenient to pull one conductor up above another one that is already in place. Therefore, install the top conductor first and then draw the others up parallel to it. The installation will look neater if care is taken at the time of installation to have the same tension on all conductors. Pull the wires up tightly. For all practical purposes, pull them as tight as you can, depending on the strength of the supports. While it is true that copper will contract in cold weather and could theoretically tighten up and break, it is also true that wires stretch considerably after they are put up.

Approximately 95 percent of the service drop conductors and 80 percent of the service entrance conductors installed today are aluminum. Overhead conductors have steel reinforcement and are known as ASCR. When installing this self-supporting three-conductor, overhead service wire, it may be necessary to use a block and tackle to hold the correct tension on the messenger wire while the wedge clamp is attached to the insulator. If a block and tackle is used, attach it to the messenger wire carefully to avoid damage which may cause it to break under tension. Some power suppliers will install this type of wire between the load center and major farm buildings as a free service, charging only for the cost of the wire.

3. Splicing Outdoor Wires

When outdoor copper wire is spliced, there are the problems of making a good electrical connection plus that of making a splice that will withstand as much tension as an unbroken wire. The Western Union splice is the type most commonly used. To make this splice, first remove the insulation from the ends of the wires for six to eight inches and thoroughly clean the exposed wire with a knife or sandpaper. Never "ring" a conductor with a knife blade when stripping insulation or you may notch the conductor and cause it to break. Use splicing clamps or two pairs of pliers and twist the wires together in a running spiral. Then "button" the ends securely at each side of the center twist.

The splice may be soldered with the aid of a propane torch, a blow torch, or a large soldering iron. First cover the splice with a thin layer of noncorrosive soldering paste. Then heat the wire and apply plain or rosin-core solder (never use acid-core). The solder melts upon contact with the heated wires and flows readily along the conductors. Cover the soldered splice with plastic or friction tape and the splice is complete.

The Western Union splice is satisfactory only for solid copper conductors. Stranded copper and aluminum conductors may be spliced with special compression-type strain connectors, some of which require a special crimping tool.

If aluminum conductors break in a wind or ice storm, temporary repairs can be made with split-bolt connectors. It would be advisable to have the power supplier make the permanent splice with specially prepared splicing materials.

5. Installing Underground Wires

If wires are run underground between buildings or between the load center and a farm building, size is usually determined by the length of run and voltage drop that may occur at a given load. Article 230-31(a) states, "Conductors shall have sufficient ampacity to carry the load. They shall not be smaller than No. 8 copper or No. 6 aluminum or copper-clad aluminum." It permits an exception, "For installations to supply only limited loads of a single branch circuit such as small polyphase power, controlled water heaters and the like, they shall not be smaller than No. 12 copper or No. 10 aluminum or copper-clad aluminum." Mechanical strength is not a limiting factor as may be the case in overhead runs. However, since the labor of installation is one of the high costs of underground wiring, it is advisable to be sure the wire is large enough to permit future expansion in the use of electricity.

Underground wiring often originates at the yard pole or load center. Individual neoprene covered trench wires, neoprene-covered cable (Type USE), or plastic-covered underground branch-circuit and feeder cable (Type UF) may be used. Run the wires inside a piece of rigid conduit or pipe down the pole from the fuse box. Section 230-32(b) states, "Where underground service conductors are carried up a pole the mechanical protection shall be installed to a point at least 8 feet above the ground." The conduit should extend about two feet below ground level. Screw a bushing on the lower end of the conduit to protect the wires from mechanical damage.

Type USE is similar to Type UF except Type USE has a heavier insulating covering. Type USE is used for service-entrance wires and may be buried directly in the earth in a trench about 24 inches deep (a minimum depth of 18 inches shall be maintained for conductors and cables buried directly in the earth). All conductors should be placed in the same trench, but separated from each other at least three inches. They should be placed in the trench with some slack to avoid damage from heaving of frost. The conductors should be covered with two inches of sand or stone-free soil. Type UF should have a six-inch "S" bend every fifteen feet for contraction and expansion.

When underground conductors are installed under driveways or other compacted places, place them in plastic pipe or six inches below a creosoted board or two-inch concrete slab for protection.

6. Electrical Supplies

Boxes are usually nailed to studding or mounted on hangers in new work installation. Some workmen use roofing nails, but pan-head sheet metal screws or round head wood screws will mount boxes more securely. When you are installing boxes, keep a supply of nails or screws in your nail apron.

Mounting straps for conduit are attached to masonry walls with lead shields, expansion fasteners, or plastic anchors.

Carry a roll of electrician's plastic tape and a roll of gray tape or friction tape on your belt.

Since grounding of boxes is required by the Code, you will find it convenient to carry grounding screws, pigtails, and grounding clips.

Cable straps are available with metal and plastic straps for mounting UF and NM cable or you may prefer to use staples.

P. Service Entrance

1. Flanged-Cap Entrance

For a small building, such as a roadside stand, pump house or movable hog house, a satisfactory entrance can be made using a flanged entrance cap. The flanged entrance cap is fastened to the wall of the building over a hole drilled through the wall at a point slightly higher than the top wire. The Code states, "To prevent the entrance of moisture, service-entrance conductors shall be connected to the service-drop conductors below the level of the service head ...." Mastic or a gasket supplied with the flanged entrance cap is used to seal around the opening. The opening in the flanged entrance cap is tapped with 1/2 inch pipe threads. Screw a cable connector into these threads from the inside of the building and insert a piece of nonmetallic cable with the outer covering removed for about two feet. The cable is then held by the connector and the ends of the wires are brought out through openings in the fiber block which is part of the entrance cap. The Code states, "Where service heads are used, conductors of opposite polarity shall be brought out through separately bushed holes."

Run the cable to a fuse box or circuit breaker box and make connections to the line side. Since this type of entrance is usually only a two-wire, 120-volt type, a 30-ampere, single-fuse box is sufficient. If a two-fuse box is used, it may be connected so that two 120-volt circuits can be taken out with a fuse to protect each one. If a breaker box is used connect the conductors.

Outside the building, connect the lead-in wires to the line wires by making twisted and soldered joints, or by using split-bolt connectors. If aluminum is to be joined to copper, use special tinned connectors with a spacer between the conductors to prevent galvanic corrosion. Section 110-14 of the Code states, "Because of different characteristics of copper and aluminum, devices, such as pressure terminal or pressure splicing connectors and soldering lugs shall be suitable for the material of the conductor and shall be properly installed and used. Conductors of dissimilar metals shall not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors." These connectors are tightened with a wrench to insure adequate pressure on the conductors and covered with electrical tape to provide adequate insualtion. When twisting a large wire and a small wire, it is best to begin the twist by hand.

Connect the black wire to the "hot" wire and the white to the "neutral" wire. The Code states, "Drip loops shall be formed on individual conductors." These are provided so that rain will run down the lead-in wires and drip off, rather than be carried into the entrance cap. The lowest point of the bottom drip loop should be at least eight feet above the ground. Section 230-50 of the Code states, "Approved service-entrance cables shall be supported by straps or other approved means within 12 inches of the service head."

2. Grounding of Service

The Code (Article 100) defines a ground: "A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or between some conducting body which serves in place of the earth." It defines a grounded conductor as "a system or circuit conductor that is intentionally grounded." This is generally referred to as the neutral. In VAS 3003b an illustration shows the center wire from a transformer as the neutral and this is a grounded conductor.

A grounding conductor is a conductor (wire) used to connect equipment or the grounded circuit to a grounding electrode. An example would be the No. 4 wire between the neutral conductor and the ground rod (electrode).

Section 250-51 lists three requirements for effective grounding. Basically these mean that the path to ground shall (1) be permanent and continuous (2) have ample carrying capacity and (3) have low impedance (AC resistance).

3. Conduit Entrance

Another common type of entrance used on larger buildings is make with conduit and fittings. Rigid conduit is preferred for parts exposed to the weather. The size of wires and conduit is determined by the electrical load planned for the building. However, the minimum size permitted by the Code for a building having 2-wire branch circuits is No. 8 wire. Three No. 8 wires can be installed in a 3/4-inch conduit. For larger size wires, consult the Code for size of conduit required.

Conduit is frequently brought down the outside of the building to a point level with the desired height of the fuse box. Use an entrance elbow at this point to permit a square turn into the building and an entrance cap or head on the upper end of the conduit to keep the rain from running down the inside of the conduit. Then, a short run of conduit inside the building leads directly into the fuse box to which it is fastened with two locknuts and a bushing or a locknut and a grounding bushing.

Grounding bushings are available. They have tapped holes for special grounding lugs. This helps insure that the conduit is adequately grounded to the box, and that paint, loose connections, and concentric knockouts do not make a connection that has high resistance.

The Code states, "All cut ends of conduit should be reamed to remove rough edges." These might cut the insulation on the wires as they are being drawn into the conduit. When conduit enters the fuse box, place locknuts on the conduit, one on the inside and one on the outside of the box to make a secure connection. Tighten the locknuts, then, place a bushing on the reamed end of the conduit to protect the wire from abrasion.

Conduit must be rigidly fastened in place when installed. To do this use straps within one foot of each outlet and not more than four feet apart along the conduit run.

Some workmen recommend the use of red lead on conduit threads to provide moisture proofing for service entrances, in basements, and other damp locations. They argue that the red lead keeps moisture out of the conduit and that the conductivity of this material maintains a good conduit grounding path. Actually red lead is basically an insulator and is not conductive. If it is used on conduit threads, then, it tends to add resistance and reduces conductivity. If you apply sufficient force to tighten the joint, you may produce a metal-to-metal contact to maintain conductivity. Such an application, however, would be a violation of the National Electrical Code which requires that "any non-conductive coating, such as paint or enamel must be removed from the threads and other contact surfaces to insure a good electrical connection," NEC Section 250-118.

After the conduit and other metallic parts of the entrance have been strapped securely in place, pull or "fish" the wires into it. Since a conduit entrance is usually a three-wire, 120-240 volt system, two black or other colored wires and one white are needed. Connect the white wire to the neutral line wire and each colored wire to one of the hot wires. Bring the wires out through separate holes in the fiber part of the entrance cap and leave enough wire for drip loops.

Service should be grounded at all major farm buildings. Attach a No. 4 or No. 6 wire, either bare or covered, to the neutral wire on the outside of the building, usually at the same point the lead-in wire is attached and bring it down the side of the building, usually behind the straps that hold the conduit. Below the entrance elbow, you may staple or strap it to the building. At the ground level, place it in a trench at least 12 inches deep, and bring it out at least two feet from the building to be attached to a ground rod driven eight feet deep. The Code specified, "Electrodes of pipe or conduit shall be not smaller than of the 3/4 inch trade size and, where of iron or steel shall have the outer surface galvanized or otherwise metal-coated for corrosion protection. Electrodes of rods of steel or iron shall be at least 5/8 inch in diameter." Use an approved ground clamp to attach the ground wire to the ground rod.

4. Service-Cable Entrance

This type of cable may be used in place of conduit as an entrance into major farm buildings. The use of service-entrance cable saves a considerable amount of labor and is frequently used for 3-wire, 120-240 volt entrances where wire sizes from No. 6 to No. 0 will suffice. Service-entrance cable consists of one or two insulated conductors wrapped with numerous strands of bare wire that form the neutral conductor. The outer covering may be cut with a knife. When removing the covering, be careful not to cut any of the strands of wire. Strip the covering back at one end about two or three feet and twist together the strands of the bare neutral conductor, to make the third conductor. Place a service-entrance cable head over the end of the cable and attach it to the building at a point just above the top wire insulator. Separate the individual ungrounded conductors and bring them out through holes in the fiber bushing.

Connect the conductors from the service entrance cable to the service drop conductors below the level of the service head or the end of the service cable sheath.

The Code states, "Service-entrance conductors should not be run within the hollow spaces of frame buildings unless provided with overcurrent protection at their outer end." Attach service cable to the outside of the building with special straps or clamps at intervals of about two feet. Bore a hole in the sill or side of the building large enough to insert the other end of the service cable so that it can be brought into the main service switch and use a sill plate with its waterproofing mastic to seal around the cable where it enters the building. Connect a ground wire and run it down the outside of the building as described for the conduit entrance.

Fasten the service cable to the fuse box or breaker box with a nonweatherproof service-cable connector. Inside the service box, separate the ends and connect them to the line terminals.

5. Entrance From Underground Conductors

It is easiest to enter an existing building by bringing the wires up the outside in conduit, using an entrance elbow where the conduit turns into the building. In a new building, the conduit can be installed inside from the entrance box down through the floor and foundation wall. The conductors are connected to the line terminals inside the fuse box.

6. Installing the Service Switch

The service switch is usually mounted inside the building near the point where the service-entrance conductors or underground feeders enter the building. Service switches are either flush mounted or surface mounted. Section 110-16A calls for a work space of at least 30 inches wide in front of electrical equipment. The intent of this requirement is that workers have enough space to work on or operate such equipment safely. Flush mounted boxes are recessed into a finished wall, anchored by screws and the conductors usually concealed by the finished wall. Surface mounted boxes are mounted on the surface of the wall and the conductors or conduit entering the box are visible. It is a good practice to mount a surface box on a backboard panel of boards or plywood so that cables or conduit can be easily anchored to the panel. Knockouts are provided in the sides of the metal box to provide holes for different sizes of connectors. These boxes should be carefully mounted in a vertical position and located where they will be readily accessible, not exposed to physical damage. and not in the vicinity of readily combustible materials.

In the fuse box the service entrance conductors are connected to terminals A and B and the neutral conductor is connected to the terminal between the ungrounded line terminals (A, B) and the ungrounded range terminals (C, D).

The 50 ampere 240-volt range circuit leads out of the knockout at the upper right-hand corner of the box. This circuit is protected by cartridge fuses located in the back of the range fuse block. Another 240-volt circuit may be connected to terminals E and F. This circuit may be used for feeders to another fuse panel that serves a hot water heater, dryer, air conditioner, or other 240-volt appliance. It is important to remember that these terminals are only fused by the main fuses in the box. Eight 120-volt branch circuits may be installed in the box.

In the breaker box the service entrance conductors are connected to terminals A and B and the neutral conductor to terminal C. The 120-volt breakers are supported by the support rails and clip on the extensions of the buss bars. The 240-volt breakers are ganged together and clip on adjacent buss bars.

The neutral bar is bonded to the box and both neutral conductors and grounding conductors are attached to the neutral bar. Some boxes have special terminals for grounding wires that are separate from the neutral bar.

Q. Wiring Techniques

1. Interior wiring may be installed on the surface or it may be concealed behind the interior finish. Most of the wiring in the outbuildings on the farm is surface wiring so that boxes, cables, or conduits are entirely exposed to view. Wiring in the home, on the other hand, is usually concealed so that only switches, receptacles, and light fixtures are visible. Boxes are set flush in the walls or ceilings and the cables are run behind the interior building finish.

   "New work" wiring is that which is done as a building is being built. The wiring of a new house or other building that has an interior finish on the walls and ceiling is done in two stages. The first stage is "roughing in." This means that boxes are mounted and cables are run to them after the framework is up but before the interior surface is applied. The final stage of installing switches, receptacles, wall plates, and light fixtures is completed after the interior finish of the walls and ceilings is done.

"Old work" wiring includes additions made any time after a building is completed. "Old work" wiring includes four types.

a. Original wiring in an existing building (rare today)
b. Complete rewiring of an old building
c. Modernization of an existing building, such as the wiring in an extension or addition
d. Maintenance or repair of old wiring, such as replacement of circuits or part of a circuit

Electrical connections are the same but for concealed wiring the problems of mounting boxes and running cables are quite different.

2. Mounting Boxes

In surface wiring of outbuildings, outlet boxes and handy boxes are generally fastened to structural members with round headed wood screws or pan head sheet metal screws. Boxes for wall switches and convenience outlets should be located as high as can be reached conveniently to avoid damage by livestock.

In concealed wiring, boxes for switches and receptacles are located between the wall studs. Wall switches should normally be located at the latch side of doors and approximately four feet above the floor line. Convenience outlets in most rooms except for the kitchen should be located about 12 inches above the floor. In the kitchen, convenience outlets are generally placed above counter-top and table height. According to the Code, convenience outlets should be located in each room of the house so that no point along the floor line of any wall space is more than six feet from an outlet.

In new work wiring, switch and receptacle boxes are fastened securely to the studs or other structural members. New work boxes often have mounting brackets which can be nailed to the sides or faces of studs. To install them properly, you should know the thickness of the plaster or other finish that is to be applied so the edges of boxes will be flush with the wall surface when it is complete.

Ceiling boxes for light fixtures should be regular octagon or square outlet boxes, supported between the ceiling joists on box hangers. Like switch boxes, they should be mounted so that the edges of the box will be flush with the ceiling finish when it is applied.

In old work wiring, Code rulings permit switch and receptacle boxes to be mounted directly upon a plaster surface when securely fastened in place. First, locate an open space between two studs by tapping on the wall. Then, make a small hole to determine what kind of wall construction is present. If you find plaster on wood lath, which is common in older homes, carefully remove an area of plaster as wide as the box and directly over one lath. Next mark the top and bottom of the proposed opening so this lath comes in the center. Carefully, saw out the center lath with a fine-tooth compass saw, starting the cut with the point of the saw in the space between the laths. It is necessary also to cut a narrow strip from the lath above and from the one below the center lath. Do not cut out two entire laths or you will have no support for screws to hold the box in place. After the cable has been "fished" and fastened into the box, attach the box firmly in place with 1-inch No. 4 or No. 5 flat head wood screws. These screws are long enough to penetrate the plaster and go into the lath and are slim enough to prevent splitting.

If the wall is plastered over gypsum board, or if "dry wall" construction has been used, special old-work boxes may be purchased which have expanding clamps on the sides that anchor the box to the wall. Mark the outline of the box on the wall surface, drill holes at the corners, and saw out the opening with a sabre saw or compass saw. After the cable has been attached, fasten the box in the wall opening by tightening the two clamp screws. Sheet metal box supports are widely used to support new boxes in old walls. The ears on top and bottom of the box seat against the outside of the wall. The sheet metal tabs are bent inward to hold the box in place.

If is not difficult to install outlet boxes for ceiling lights if there is unfinished attic space above that is accessible. Cut an opening in the ceiling the size and shape of the octagon or square box being used. Then, support the box on a bar hanger, which is nailed to the ceiling joists on either side of the hole. The edges of the box should project through and be flush with the ceiling surface.

If space is not accessible above the ceiling the Code permits you to use shallow ceiling boxes that are 1/2 inch deep. Remove enough plaster to expose a lath between two ceiling joists. Mark around the box with a pencil with the exposed lath in the center. Remove plaster carefully from the marked area and cut away the center lath. Tie a piece of wire to an old-work hanger, insert the hanger in the hole and adjust it by pulling on the wire until it is crossways on the lath with the fixture stud extending down through the hole. Mount the shallow ceiling box on the fixture stud.

3. Wiring With Cable

The Code states, "Cable shall be secured by approved staples, straps, or similar fittings so designed and installed as not to injure the cable." Cable shall be secured every 4½ feet and within 12 inches from every cabinet, box, or fitting where the work is exposed. Care should be taken to stretch the cable when installing it so it is taut and does not sag between mounting straps. Metal straps that have the nails attached are less likely to damage the cable than staples.

Bends in cable should be made so the protective covering is not damaged. No bend shall have a radius less than five times the diameter of the cable.

When cable passes through a floor (as up into a hay mow), it should be enclosed in rigid metal conduit or pipe at least six inches above the floor. When concealed or exposed cable is installed through bored holes in studs or joists, the holes shall be bored at the approximate center of the members or at least two inches from the nearest edge. Cable may be laid in notches in studding or joists when the cable is protected at those points against the driving of nails by having the notch covered with a steel plate at least 1/16 inch in thickness before the building is finished.

In unfinished basements where the cable is run at angles with the joists, cable not smaller than two No. 6 or three No. 8 conductors may be secured directly to the lower edges of joists. Smaller cables shall be run either through bored holes in the joists or on running boards. Where the cable is run parallel to joists, cable of any size shall be secured to the sides of the joists.

The Code states, "A box shall be installed at each outlet, switch point, or conductor splice connection joining sections of....non-metallic sheathed cable." The cables should be firmly attached to every box with cable clamps or connectors. The outer sheath of the cable should extend under the clamp. Be careful when tightening cable clamps and non-metallic cable connectors that you do not damage the insulation and make contact between the conductors and the box. The Code further states, "At least six inches of free conductor shall be left at each outlet and switch point for the making up of joints or the connection of fixtures or devices."

Cut the outer covering with a knife or cable ripper and remove it, leaving at least six inches of free wire in the box for making splices or connections. On UF cable, a sharp knife can be used to slit the outer covering over each conductor. Be careful when stripping the sheath from cable that the insulation of the condutors is not nicked. Since UF cable is usually quite stiff, be extremely careful with it to avoid nicking the insulation.

Some electrical contractors and builders are using NM cable with aluminum or copper clad aluminum conductors. The Code rating for copper clad conductors is the same as for aluminum: #12--15 amps., #10--25 amps. The copper clad aluminum is approved for use with UL listed wiring devices of the "push-in" type.

Some failures of receptacles wired with aluminum wire have been caused by using backwired receptacles (push-in type), or by failing to tighten the binding screws. In some cases the aluminum was not compatible with the terminals and corrosion and arcing occurred. Vibrations, temperature changes and humidity have also been responsible for failures in aluminum wiring.

In order to avoid these problems, the Aluminum Association recommends these practices. Use only receptacles marked with CO/ALR label. This means that the devices have been tested to withstand a severe overload to determine their suitability. Underwriter's Laboratories state that the following types of devices may be used with UL labeled copper or copper clad aluminum conductors but shall NOT be directly connected to alumimum conductors:

a. Receptacles and snap switches marked "AL-CU".
b. Receptacles and snap switches having no conductor marking.
c. Receptacles and snap switches having back wired terminals or screwless terminals of the push-in type.

Give special attention to attaching aluminum conductors to binding screws.

a. Wrap the stripped end of the wire 2/3 to 3/4 of the distance around the post of the wire-binding screw.
b. Tighten the screw until the wire is snugly in contact with the underside of the screw head and the contact plate marked CO/ALR.
c. Tighten the screw an additional 1/2 turn. This insures a firm connection. If a torque screwdriver is used, tighten to 12 pound-inches.
d. Position the wires so as to decrease the likelihood of loosening terminals screws when mounting the device to the outlet box.

Do not use the following devices with alumimum conductors. They may be used with copper or copper clad conductors.

a. Receptacles and snap switches marked "AL-CU".
b. Receptacles and snap switches having no conductor marking.
c. Receptacles and snap switches having back wired terminals or screwless terminals of the "push-in" type.

The CO/ALR marking applies only to 15 and 20 amp wiring devices. All other devices, such as circuit breakers, oven, and dryer receptacles continue to be marked AL/CU when approved for use with aluminum.

4. Wiring With Conduit

Some wiring may be done in conduit, especially where mechanical protection is desired. Conduit wiring, when properly installed and maintained, grounds the electrical system for added safety. Conduit also has the advantages of permitting a wider choice of wire colors for different circuits and permitting easier extensions since additional conductors may be pulled into conduit runs.

Thin-wall conduit is not threaded but uses fittings that are attached by compression rings or set screws. The conduit should be mounted in place and connected to boxes before the wires are "fished" in. Conduit must be used with steel boxes only. It comes in 10-foot lengths which are joined with couplings. You can make shorter lengths by cutting it with a 32-tooth hacksaw or a special wheel-type cutter. Be sure to smooth the inside edges of cuts with a reamer or a rat-tail file. Attach thin-wall conduit to boxes with connectors. Fit a connector with pressure ring over the end of the conduit and tighten with wrenches. Insert the other end in a knockout opening in a box and tighten the locknut with a screwdriver or slip-joint pliers until the nut bites into the metal of the box.

Conduit is made to bend into shape easily and bends shall be so made that the tubing will not be injured and the internal diameter will not be effectively reduced. The run of conduit shall not contain more than the equivalent of four quarter bends. One type of bend frequently needed is the "offset", used to raise the conduit from a surface to any desired height. If conduit is run directly into a box, it will not fit snugly to the surface because the knockout is a short distance from the back of the box. An offset bend permits the box to lie flat on the surface and the conduit to quickly return to the surface.

To bend a standard box offset, place the conduit on the floor and hook the bender close to one end. Pull on the bender until the handle is at a 45° angle to make the first bend. Then turn the conduit over and hook the bender under the center of the first bend. Bend up again until the short end is parallel to the main piece of conduit.

Suppose it is necessary to make a 90° bend in a piece of 1/2-inch thinwall conduit so that is will fit into an outlet box whose lower edge is 12 inches above a workbench. Place a mark on the conduit a set distance from the end, depending on the type of bender used. Most benders add 5 or 6 inches in making a 90° bend. You subtract this fixed amount from the 12 inches and mark the conduit at this point and make a 90° bend with a single downward movement of the bender. The distance from the bottom edge of the conduit to the end should be 12 inches and the piece will fit.

Support conduit by a strap every six feet and mount the boxes securely with screws. Tighten all couplings and connectors firmly so that the entire metal raceway provides electrical continuity for grounding the system back to the main service entrance.

After the conduit and boxes are in place, you are ready to pull in the wires. Fish tape, made of spring steel, may be inserted in the conduit and attached to the conductors. Then as the tape is withdrawn, the conductors are "pulled" into the conduit. At least six inches of free conductor should be left at each outlet and switch box to connect splices or devices. Even if no connection is planned at the box a loop should be left in the conductor to facilitate later connections.

5. Make Electrical Connections

   a. Remove the insulation only at the ends of the wires when preparing to make a splice or connection. This may be done with a knife, wire stripper, a pair of lineman's pliers or diagonal cutters. If a knife is used, cut the insulation at an angle down to the wire and along it to the end. The insulation may then be peeled back and cut off. If lineman's pliers or diagonal cutters are used, the insulation may be crushed between the handles and pulled or cut off. In either case, be careful not to nick the wire because it may break at the nick when twisted or wrapped around the terminal screw.

      Where splices are necessary, they may be made in one of several approved ways. The twisted and soldered "pigtail" splice is made by twisting at least one and one-half inches of the wires together. The end is then cut off, bent back, and the whole joint soldered using a nonacid flux. A convenient way to do this is to apply a paste flux and then dip the splice into a dipper of melted solder. After soldering, cover the joint with plastic electrician's tape. The object is to insulate the splice at least as well as the uncut wire.

      Ordinary branch circuit wiring is usually done with solid conductors while fixtures and appliances are connected with stranded conductors. When it is necessary to splice these together, wrap the stranded conductor around the solid conductor several times and then bend back the solid conductor parallel to the splice. This connection may then be soldered before taping.

When taping a splice, lock the end of the tape between the conductors and spiral the tape over the splice or connector. Continue the spiral past the end of the splice, fold the tape back, and complete the taping by spiraling back to where the conductors branch. The end of the splice is one critical area that must be well insulated as it is likely to be pressed against the box and may create a shock hazard.

In most cases today, solderless connectors or splicing devices are used in place of twisting and soldering. Consult a chart of wire combinations to determine if the connector can be properly used with the kind (copper or aluminum) type (solid or stranded) and size (AWG Number) and number of conductors. It is important to strip the wires only as far as the instructions specify for a particular connector. Hold the stripped ends together and push the wires firmly into the mouth of the connector. The connector may then be secured by twisting or tightening a locking screw or using a compression tool. Careful wiremen check the connection to see that no bare conductors are exposed and that all conductors are secure in the connector.

Wires that are No. 8 stranded or No. 6 and larger, should be attached only to lugs made for heavy wires, and not to ordinary screw terminals. If it becomes necessary to attach heavy wires to small terminal screws, special lugs are available in both solder and solderless types.

When fastening a wire to a switch or receptacle, an eye or loop should be made in the end of the wire to provide good contact between the screw and the base. To make such a connection, remove from 1/2 to 3/4 inch of insulation from the end of the wire, make a right-angle bend in the wire, and with long nose pliers draw the end into a loop. Be sure the wire passes clockwise around the screw so it will be tightened as the screw is drawn up. The insulation should run right up to the screw.

Some terminal screws are approved for holding wires not formed into loops. Some of these are approved for connecting two wires--one under each side of the screw should be used for one wire in a loop only (see Code Section on Connection to Terminals).

The conductors forming a pigtail splice should be formed into a curve and pressed into the boxes. Care should be taken so the tape or insulation is not cut or nicked on the edge of the box. If solderless connectors are not securely twisted on, they may come loose as the wires are pressed into the box. The wires attached to switches, fixtures, and devices should be folded so they can be placed in the box without nicking the insulation or pinching them against the side of the box.

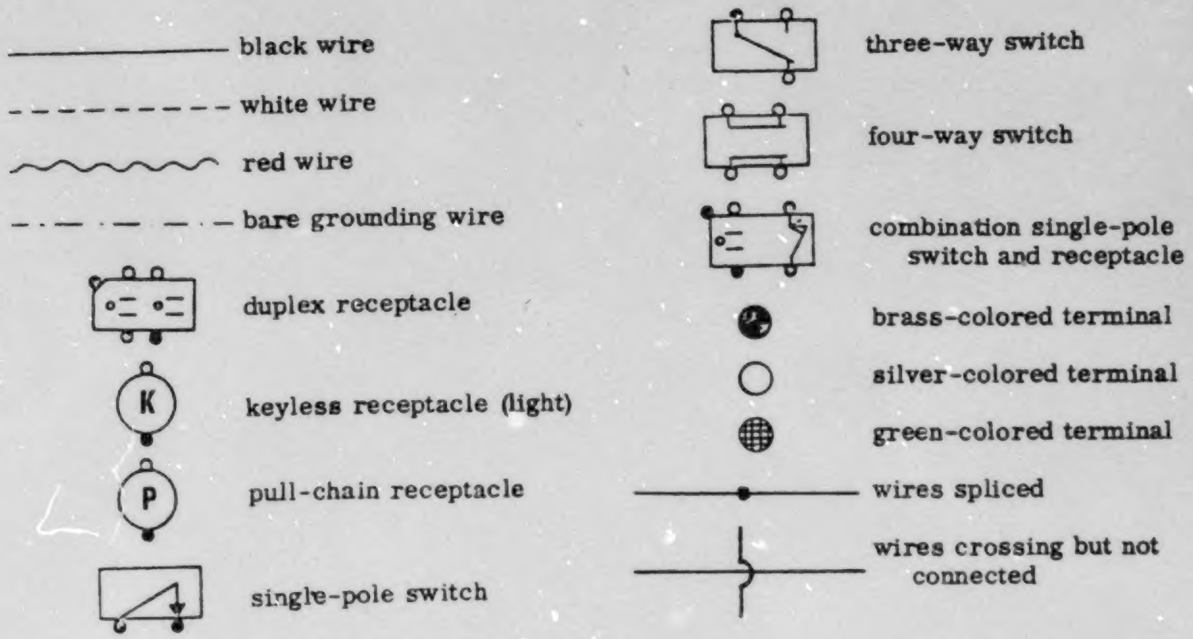
R. Wiring Electrical Devices

1. The circuit to a light or other device is complete when the current can flow from the source to that device and back to the source. If the electrical path is broken at any point, the circuit is not complete and the device will not operate. A switch is placed in one of the wires when we wish to control a device. The switch closes the circuit to turn the device on and opens the circuit to turn it off.

2. Drawing Wiring Diagrams

It is helpful to first draw a wiring diagram of the circuit before attempting to connect it. It even helps you learn to plan on the materials needed and avoid many mistakes made in "trial and error" wiring.

Symbols used in drawing wiring diagrams should be simple and easy to make. The following symbols will be used in this publication:


black wire
white wire
red wire
bare grounding wire
duplex receptacle
K
keyless receptacle (light)
P
pull-chain receptacle
single-pole switch
three-way switch
four-way switch
combination single-pole switch and receptacle
brass-colored terminal
silver-colored terminal
green-colored terminal
wires spliced
wires crossing but not connected

3. Wiring a Receptacle

In conduit wiring, where the conduit has been carefully installed with tight joints, all of the boxes in the system are effectively grounded. If a grounding-type receptacle is mounted securely on one of these boxes, no special grounding conductor is necessary. The U-shaped slots in the receptacle are grounded through the mounting strap to the conduit.

Soldering of grounding conductors in non-metallic cable is not permitted. Section 250-113 states, "The grounding conductor, bond or bonding jumper, shall be attached to circuits, conduits, cabinets, equipment, etc., which are to be grounded, by means of suitable lugs, pressure connectors, clamps or other approved means, except that connections which depend upon solder shall not be used."

Other metal boxes, used in farm buildings wired with nonmetallic cable, must be grounded by connecting the bare grounding wires from the cable to the box.

Connecting the grounding conductor (bare wire) of nonmetallic sheathed cable to the grounding screw of the receptacle does not meet the Code requirements even though the new receptacles have "automatic grounding" features. Section 250-74 states, "Grounding continuity between a grounded outlet box and the grounding circuit of the receptacle shall be established by means of a bonding jumper between the outlet box and the receptacle grounding terminal." The box must be connected to the grounding conductor. This grounds the box. By using the "automatic grounding" type receptacles, there may be no need for a bonding jumper between the box and the receptacle. The important thing to remember is that the grounding conductor must be connected to the box not the receptacle. In case the receptacle is removed in the future, the box is still grounded.

Grounding of boxes may be done in three ways. In "old work" where the boxes are already installed, a grounding clip can be driven on the edge of the box. These clips may also be used on new boxes. New boxes are tapped for 10/32" machine screws and washer head grounding screws can be used to attach the grounding wires. Several companies sell grounding pigtails that are attached to grounding screws.

4. Wiring a Duplex Receptacle

There is no rule on how receptacles should be mounted so give some consideration to the location and use before mounting them. The most common method of mounting receptacles is with the grounding slot down. If the attachment plug is pulled out slightly, then a thin metal object (paper clip, hairpin) that falls between the plug and the receptacle will strike a current carrying blade. If the grounding slot is up, then, the object will strike the grounding blade first and be deflected so this method is considered the safest.

Some molded plugs are made so the cord will stick up when they are inserted in a receptacle with the grounding slot up. Under these circumstances it would be best to place the grounding slot down.

Each situation should be examined and the best method of installation should be chosen.

In the case of split-circuit duplex receptacles, it is suggested that the bottom portion be controlled with a switch and the top portion be "hot" at all times. The reasoning behind this is that the owner may wish to attach a lamp in the bottom portion of the receptacle and use the unswitched top portion for a clock, radio, television, etc. which is not obstructed by the lamp cord.

A new style of nonmetallic boxes are available. These boxes are tough and do not shatter under impact. A grounding plate can be provided for grounding fixture straps and pigtails to them.

5. Wiring a Pull-String Receptacle

It is customary to wire a pull-chain receptacle to be "hot" all the time as the control switch is built into the fixture. If the pull-chain receptacle is at the end of a run of cable, the wires can be connected directly to its terminal screws, white wire to silver-colored terminal and black wire to brass-colored terminal. If the line is to continue on, however, a "pigtail" connection should be used because the terminal screws on pull-chain receptacles ordinarily permit only single-wire connections.

6. Wiring a Single-Pole Switch

When a light is controlled by a switch, the neutral wire should always go directly to the screw-shell of the socket (attached to the silver-colored terminal). The hot wire goes first to the switch and from the switch to the brass-colored terminal of the light socket.

a. Feed-Through Connection

The line from the source may be brought first into the switch box and then on to the box containing the light. In this case splice the white wires (neutrals) together in the switch box and connect the black wires to the switch.

If you wish to carry a switched line on beyond the light to another light or series of lights to be controlled by the single-pole switch, make pigtail connections in the octagon box.

If you wish to carry an unswitched line beyond the light, it is necessary to use a piece of three-wire cable between the switch box and the light. Then, it is customary to use the red wire as the switched wire and the black wire as the unswitched wire. Pigtail connections are necessary

b. Switch-Loop Connection

It is frequently desirable to bring the source wires into the box at the light first and place the switch box at the end of a piece of cable. This is called a switch loop. When using two-wire cable for a switch loop, it is necessary to use the white wire as the hot line to the switch. This is specifically required by the Code which states that the unidentified (black) wire shall be used as the return from the switch to the light. Black and white wires are thus connected together in the box at the light but the wires are of proper color where connected to the light.

This connection of black to white is not necessary in conduit wiring as wires can be inserted in the conduit in any combination of colors desired. It is customary to wire a switch loop in conduit with a black wire leading to the switch and a red wire leading from the switch to the light.

7. Wiring Three-Way Switches

Three-way switches are used to control a light or device from two different locations. Three-way switches have three terminal screws, one of which connects to what we may call the "common" terminal. In one position of the toggle, current is carried from the common terminal to one of the "traveler" terminals. In the other position, current is carried from the common terminal to the other traveler terminal.

A pair of three-way switches may be connected in any one of three positions relative to the source and light.

a. Both switches may be between the source and the light
b. The light may be between the source and the switches
c. The light may be between the two switches

The third position may have two variations. In one, the line from the source is brought in to the light first, and in the other it is brought in through one of the switch boxes.

The basic connection for all of these variations is the same although the mechanics are different. In each case the neutral wire goes directly to the light, the hot wire from the source goes to the common terminal of one of the three-way switches, the traveler wires connect the traveler terminals of the switches, and the common terminal of the other three-way switch is connected to the light.

8. Wiring Four-Way Switches

Four-way switches are installed between two three-way switches to control a light from more than two locations. A four-way switch has four terminals and is connected in such a way that it "breaks" the traveler wires.

Four-way switch terminal A is connected to B and C to D when the toggle is in one position. In the other position, the connection crosses over from A to D and from C to B.

Three-way and four-way switches can be arranged in several positions relative to the source and light. There are three positions most common for cable wiring. Some other positions requiring four wires between boxes may be used with conduit but not with cable since 4-wire cable is not readily available.

9. Wiring a Combination Single-Pole Switch and Receptacle

If a plug-in receptacle is desired in the same box with a switch, a combination unit may be installed. In most cases, the switch controls a light or series of lights and the receptacle is "hot" all the time. In special cases, the switch may be wired to control the receptacle also.

The combination switch and receptacle may be connected to feed-through position or in switch-loop position. Note that the neutral wire must be connected to the receptacle and that three-wire cable is required between the switch box and the light for the switch-loop position.

S. Electrical Tools and Supplies

1. If you plan to install new electrical work, or repair or replace existing wiring, you need to have the proper tools. In addition to having the proper tools they should be easy to reach.

Many electricians prefer to carry some of their hand tools with them and develop the habit of carrying a pouch (tool holster) of tools on their belt. This habit saves many steps and time and makes you a more efficient worker. The tools should also be in good condition.

2. Drilling Tools

If you are installing a service entrance with cable, you may need a brace, auger bits, and perhaps an expansive bit that can be adjusted to bore holes larger than one inch in diameter. When working in old houses, a bit extension is also useful.

If electrical conduit is to be run through floors or walls, a hole saw used with a power drill will quickly make a hole of the correct size. When nonmetallic cable is to be run at an angle with joists or through studding a flat wood bit and a portable drill will help you complete the job quickly. You will need masonry bits to mount anchors in concrete or masonry.

A hand drill or push drill will be helpful in drilling pilot holes for wood screws when mounting electrical boxes on the surface.

3. Tools for Conduit

Rigid conduit is often used for service entrances and must be cut, reamed, and threaded with regular pipe tools. The conduit is conveniently supported in a pipe vise and cut with a pipe cutter. After the conduit is cut, you need threading dies to cut threads on the conduit and a reamer to remove the sharp ridge from the inside. Pipe wrenches are used to assemble the conduit and fittings.

Conduit has to be bent and offsets made for boxes. A conduit bender can be used for both jobs but a special tool makes it easy to make perfect offsets in thin wall conduit.

Thin wall conduit can be cut quickly with a hacksaw with 32-teeth one-inch blade or a wheel cutter may be used. The hacksaw is also used to cut large cable and conductors.

All conduit is installed unwired, then the wires are pulled through with a "fish tape."

4. Hammer

Electrical boxes and hangers are generally nailed to structural members so you will need a hammer. You can remove a baseboard or molding more easily with a ripping claw hammer than with a curved claw hammer.

5. Measuring Tools

You will need some measuring device to help you accurately locate boxes and tc measure the length of wire, conduit, and the like. You may wish to use a folding ruler but they must be carried in a tool pouch or pocket. Flexible tapes usually have a clip on them to attach to your belt. The tape that retracts into a case requires less time to use than a folding rule.

6. Screwdrivers

You will need several different screwdrivers in a day's work. An electrician's screwdriver has a narrow blade that is ideal for mounting switches and receptacles in boxes. A screwdriver with a larger blade will be more convenient for tightening work binding screws. A heavy duty screwdriver will be needed for mounting boxes and straps.

7. Pliers

Electrical side cutting pliers are available in several sizes. Most electricians use the 7- or 8-inch size. These pliers are large enough to cut heavy nonmetallic cable (10/3 etc.). They have flat gripping jaws that are used to hold, pull, bend, and twist wires, and side cutting jaws. You will find it is convenient to crush insulation between the shoulders of the handles. You may want to buy insulated covers for the handles if the pliers do not already have them.

Long-nose pliers are very useful for reaching into narrow openings to withdraw wires and for bending loops in wires to fit under screws. Long-nose pliers are available in several sizes.

Diagonal cutters have the cutting jaws exposed and are convenient for cutting ends cf conductors close to screws.

Water pump pliers are used to tighten thin wall conduit connectors, cable connectors, and locknuts.

8. Cable Ripper

The cable ripper is used to slit the sheath on nonmetallic cable. Several different styles of these are available and they provide an efficient way to quickly remove the sheath from nonmetallic cable.

9. Test light

Various kinds of test lights can be purchased. Some electricians construct one from a weather proof socket and a 120- or 240-volt bulb. If the bulb is partially covered with electrical tape, it reduces breakage. The 240-volt bulb burns brightly on a 240-volt circuit and dimly on a 120-volt circuit.

Neon test lights are available in at least two styles. One has two short leads while the other is a long cable. With these testers you can determine the hot and neutral conductors in old work where it is hard to see the color of the insulation.

10. Knife

An electrical pocket knife usually has spring loaded lock to keep the blade from closing accidentally. These knives are used to remove the sheath and the insulation from wires.

11. Special Tools

Some electrical appliances and fixtures are assembled with socket head screws so you may need special screwdrivers for these. These screwdrivers are known by various trade names, such as "clutch head, cross point, 1/4" drive, hexagon head, internal wrench, etc." Another type of screwdriver that is handy for working in cramped quarters is a screw-holding screwdriver.

A combination wire stripper, machine screw cutter, and crimping tool will speed up your work on these jobs. There are several styles. A special wire stripper will strip the insulation quickly but you must be careful to insert the wire in the correct jaws in the stripper.

A small piston grip hacksaw or compass saw is useful to cut outlined openings in wallboard and plaster where you want to add boxes and fixtures.

Appendix A

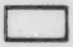
ELECTRICAL WIRING EXERCISES

The following wiring exercises are intended for use with a loan kit of electrical supplies, but may be used for practice wiring if the standard materials specified are available from any source. The exercises are divided into five groups:

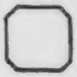
1. Entrance exercises
2. Elementary wiring exercises
3. Secondary wiring exercises
4. More difficult wiring exercises
5. Group exercise

The entrance exercises provide practice in bringing electrical service into various types of farm buildings. Two of these entrances may be left as a source of power for the other exercises that follow.

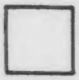
The symbols used in the illustrations are as follows:



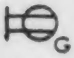
Switch box or
handy box



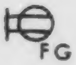
Octagon box



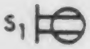
Square box



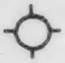
Grounding-type
duplex receptacle



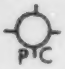
Single grounding
receptacle with fuse



Combination single-pole
switch and receptacle



Keyless lampholder



Pull-chain lampholder

S_1

Single-pole switch

S_3

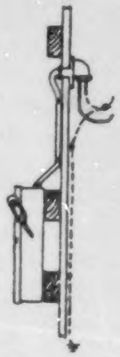
Three-way switch

S_4

Four-way switch

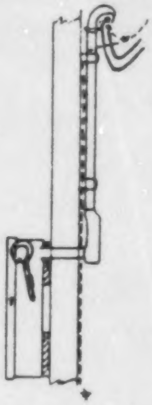
1. ENTRANCE EXERCISES

Entrance Situation 1. Service is needed in a small portable hog house for heat lamps. This service will not be needed longer than a few weeks.



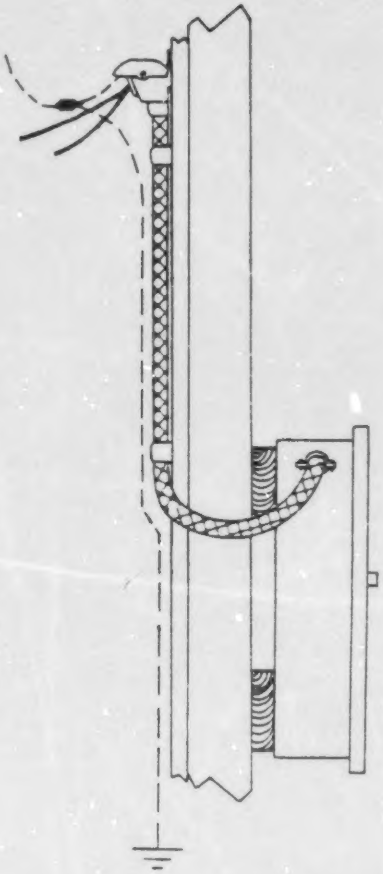
Feeder Entrance 1. Wire a feeder entrance into a small building, using a flange-type entrance head, 1 piece of nonmetallic cable with ground, 1 30-ampere fused switch, 2 No. 6 split-bolt connectors, bare ground wire, ground rod and clamp, and 2 cable connectors.

Entrance Situation 2. Service is needed for a 230-volt motor on an air compressor and the entrance can remain a permanent part of the tool shed.



Feeder Entrance 2. Wire a feeder entrance into a building using 2 pieces of 3/4-inch rigid conduit, individual conductors of proper size, length, and colors, a 3/4-inch conduit entrance head, a 3/4-inch conduit entrance elbow, a 30-ampere fused switch, 2 3/4-inch conduit locknuts, 1 3/4-inch conduit bushing, 2 No. 6 split-bolt connectors, 1 No. 4 split-bolt connector, bare ground wire, ground rod and clamp, and 2 3/4-inch conduit straps.

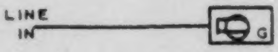
Entrance Situation 3. A 100-ampere service is needed for a large farm shop to provide a 50-ampere 240-volt circuit for a welder, a 30-ampere 240-volt circuit for large power tools, three 15-ampere 120-volt circuits for lighting, and three 20-ampere 120-volt circuits for receptacle outlets, one circuit to have ground-fault protection.



Feeder Entrance 3. Wire a feeder entrance into a building using service-entrance cable of proper size, a service cable entrance head, a $1\frac{1}{4}$-inch nonweatherproof service cable connector, a 100-ampere circuit breaker entrance switch, three No. 2 split-bolt connectors, bare ground wire, ground rod with clamp, and service cable straps.

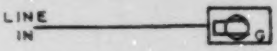
2. ELEMENTARY WIRING EXERCISES

Situation 1. An unswitched duplex receptacle is needed for a radio in the farm shop.



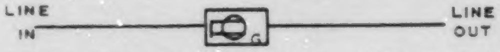
Exercise 1. Wire a duplex receptacle with an unswitched line in, using 1 piece of nonmetallic cable (NM) with bare ground, 1 handy box, 1 grounding-type duplex receptacle, 1 handy box cover for duplex receptacle, and 1 cable connector.

Situation 2. An unswitched duplex receptacle is needed for a portable drill in the farm shop.



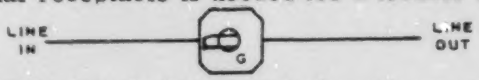
Exercise 2. Wire a duplex receptacle with an unswitched line in, using 1 piece of underground feeder and branch circuit cable (UF) with bare ground, 1 handy box, 1 grounding-type duplex receptacle, 1 handy box cover for duplex receptacle, and 1 cable connector.

Situation 3. An additional wall receptacle is needed in the living room.



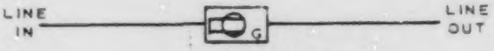
Exercise 3. Wire an unswitched duplex receptacle with an unswitched line in and out, using 2 pieces of NM cable with bare ground, 1 3½" deep switch box with cable clamps, 1 grounding-type duplex receptacle and 1 bakelite wall plate for duplex receptacle.

Situation 4. An additional receptacle is needed for a trouble light in the machinery storage shed.



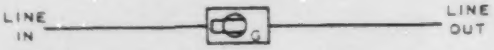
Exercise 4. Wire an unswitched duplex receptacle with an unswitched line in and out, using 2 pieces of NM cable with bare ground, 1 four-inch octagon box, 1 grounding type duplex receptacle for octagon box, and 2 cable connectors.

Situation 5. An outlet is needed for a portable auger elevator motor in the driveway of the corn crib.



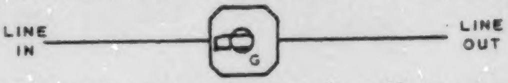
Exercise 5. Wire an unswitched duplex receptacle with an unswitched line in and out, using 2 pieces of ½-inch thinwall conduit, individual indoor conductors of proper length and colors, 1 handy box, 1 grounding-type duplex receptacle, 1 handy box cover for duplex receptacle, and 2 connectors for ½-inch thinwall conduit.

Situation 6. A grounding type receptacle is needed near the door of the shop for the portable electric saw.



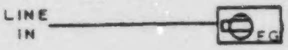
Exercise 6. Wire an unswitched duplex receptacle with an unswitched line in and out, using 2 pieces of ½-inch thinwall conduit, indoor conductors of proper length and colors, 1 handy box, 1 grounding-type duplex receptacle, 1 handy box cover for duplex receptacle, and 2 connectors for ½-inch thinwall conduit.

Situation 7. An outlet is needed on the farm shop wall for an electric clock.



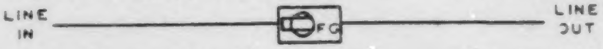
Exercise 7. Wire an unswitched duplex receptacle with an unswitched line in and out, using 2 pieces of NM cable with bare ground, 1 four-inch octagon outlet box, 1 grounding type duplex receptacle for octagon box, and 2 cable connectors.

Situation 8. A fused grounding type receptacle is needed in the basement for the sump pump.



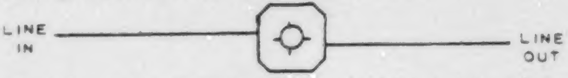
Exercise 8. Wire a single grounding receptacle and fuse holder with an unswitched line in, using 1 piece of NM cable with bare ground, 1 handy box, 1 single grounding receptacle with fuse holder, and 1 cable connector.

Situation 9. A fused grounding type receptacle is needed for an automatic washer in the basement.



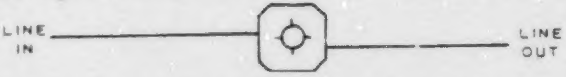
Exercise 9. Wire an unswitched single grounding receptacle with fuse holder, with an unswitched line in and out, using 2 pieces of $\frac{1}{2}$-inch thinwall conduit, indoor conductors of proper length and colors, 1 handy box, 1 single grounding receptacle with fuse holder, and 2 connectors for $\frac{1}{2}$-inch thinwall conduit.

Situation 10. A light is needed in the feedway next to the silo and the wire must be buried under the driveway between the silo and the barn.



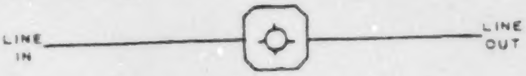
Exercise 10. Wire an unswitched keyless lampholder with a line in and out, using 2 pieces of UF wire with bare ground, 1 four-inch octagon box with cable clamps, and 1 four-inch porcelain keyless lampholder.

Situation 11. Another light is needed over the automatic washer in the basement.



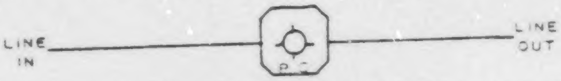
Exercise 11. Wire an unswitched keyless lampholder with a line in and out, using 2 pieces of NM cable with bare ground, 1 four-inch octagon box with cable clamps, and 1 four-inch porcelain keyless lampholder.

Situation 12. An additional light is needed in the farrowing house.



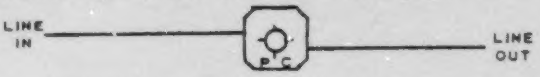
Exercise 12. Wire an unswitched keyless lampholder with a line in and out, using 2 pieces of $\frac{1}{2}$-inch thinwall conduit, indoor conductors of proper length and colors, 1 four-inch octagon box, 1 four-inch keyless porcelain lampholder, and 2 connectors for $\frac{1}{2}$-inch thinwall conduit.

Situation 13. A light is needed occasionally over the automatic waterer in the cattle shed.



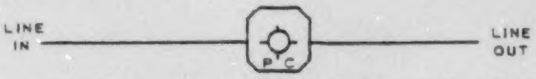
Exercise 13. Wire an unswitched pull lampholder with an unswitched line in and out, using 2 pieces of UF cable with ground, 1 four-inch octagon box, 1 four-inch porcelain

Situation 14. An additional light is needed over the bolt rack in the farm shop.



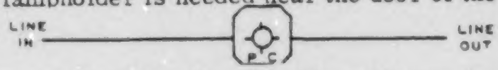
Exercise 14. Wire an unswitched pull lampholder with a line in and out, using 2 pieces of UF cable with bare ground, 1 four-inch octagon box with clamps, and 1 four-inch porcelain pull-chain lampholder.

Situation 15. A light is needed to check the controls on the water system in the pump house.



Exercise 15. Wire an unswitched pull-chain lampholder with a line in and out, using 2 pieces of ½-inch thinwall conduit, indoor conductors of proper length and colors, 1 four-inch octagon box, 1 four-inch porcelain pull-chain lampholder, and 2 connectors for ½-inch thinwall conduit.

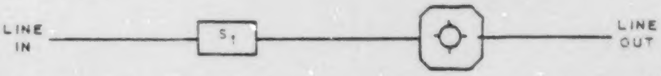
Situation 16. A pull lampholder is needed near the door of the laying house.



Exercise 16. Wire an unswitched pull lampholder with line in and out, using 2 pieces of UF cable with bare ground, 1 four-inch octagon box, 1 four-inch keyless porcelain lampholder, and 2 cable connectors.

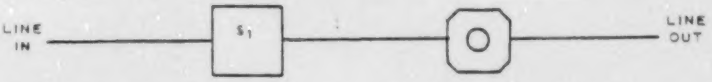
3. SECONDARY WIRING EXERCISES

Situation 17. A light, controlled by a wall switch near the back door, is needed in the rear hall of the house.



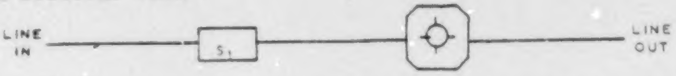
Exercise 17. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in at the switch and out at the light, using 3 pieces of NM cable with bare ground, 1 four-inch octagon box, 1 conduit switch box 3½" deep, 1 four-inch porcelain keyless lampholder, 1 single-pole switch, 1 bakelite wall plate, and 4 cable connectors.

Situation 18: A furnace room light is needed. It is to be controlled by a switch mounted on the wall of the furnace room.



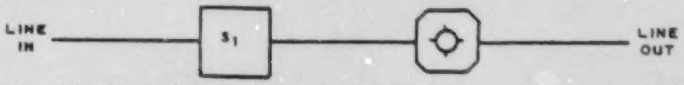
Exercise 18. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in at the switch and out at the light, using 3 pieces of NM cable with ground, 1 four-inch square box, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 1 single pole switch, 1 four-inch square box cover for toggle, and 4 cable connectors.

Situation 19. A light is needed on the ceiling of the clothes closet that can be controlled by a switch in the bedroom wall.



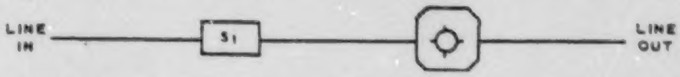
Exercise 19. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in at the switch and out at the light, using 3 pieces of NM cable with bare ground, 1 four-inch octagon box, 1 conduit switch box 3½" deep, 1 four-inch porcelain keyless lampholder, 1 single-pole switch, 1 bakelite wall plate, and 4 cable connectors.

Situation 20. A light is needed in the farrowing house controlled by a switch mounted on the studding near the door.



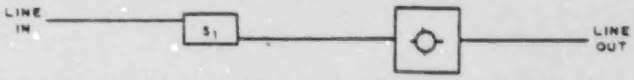
Exercise 20. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in at the switch and out at the light, using 3 pieces of UF cable with ground, 1 four-inch square box, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 1 single-pole switch, 1 four-inch square box cover for toggle switch, and 4 cable connectors.

Situation 21. In order to service farm implements after dark, a light is needed above the door inside the pole type machine shed. The switch is to be mounted beside the door.



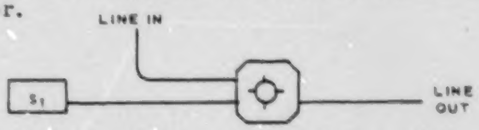
Exercise 21. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in at the switch and out at the light, using 3 pieces of ½-inch thinwall conduit, indoor conductors of proper length and colors, 1 four-inch octagon box, 1 handy box, 1 porcelain keyless lampholder, 1 single-pole switch, 1 handy box cover for toggle switch, and 4 connectors for ½-inch thinwall conduit.

Situation 22. A light is needed on the ceiling of the utility room. The switch for the light is to be mounted next to the door.



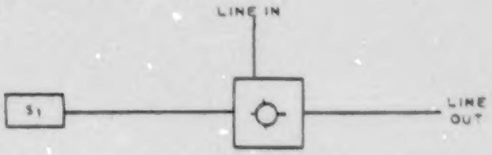
Exercise 22. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in at the switch and out at the lampholder, using 3 pieces of NM cable with bare ground, 1 3½" deep switch box with cable clamps, 1 four-inch square box, 1 four-inch square keyless lampholder, 1 single-pole switch, 1 bakelite wall plate for toggle switch, and 2 cable connectors.

Situation 23. It has been decided to mount a ceiling light in the front hall. This light is to be inserted in a circuit that passes over the hall and the switch is to be in the wall near the front door.



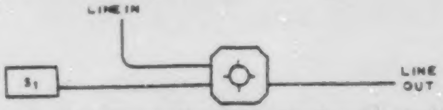
Exercise 23. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out, using 3 pieces of NM cable with bare ground, 1 four-inch octagon box with clamps, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder to represent fixture, 1 bevel corner switch box, 1 single-pole switch, and 1 bakelite wall plate for toggle switch.

Situation 24. A light is needed near the bulk tank in the milk house. The switch to control this light is to be next to the door.



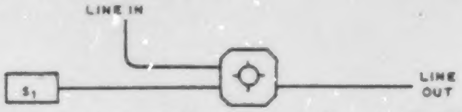
Exercise 24. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out, using 3 pieces of UF cable with bare ground, 1 four-inch square box, 1 four-inch square keyless lampholder, 1 handy box, 1 single-pole switch, 1 handy box cover for toggle switch, and 4 cable connectors.

Situation 25. More light is needed over the food preparation area in the kitchen. The switch for this light is to be mounted in the wall.



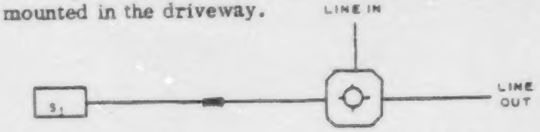
Exercise 25. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out, using 3 pieces of NM cable with bare ground, 1 four-inch octagon box with clamps, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder to represent fixture, 1 bevel corner switch box, 1 single-pole switch, and 1 bakelite wall plate for toggle switch.

Situation 26. A light is needed over the self-feeder in the confinement swine finishing house. The switch is to be along the service walkway.



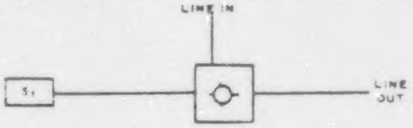
Exercise 26. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out at the light, using 3 pieces of UF cable with bare ground, 1 four-inch octagon box with clamps, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder, 1 handy box, 1 single-pole switch, 1 handy box cover for toggle switch, and 1 cable connector.

Situation 27. In order to unload hopper bottom grain wagons after dark an additional light is needed in the driveway of the crib with overhead storage. This light is to be controlled by a switch mounted in the driveway.



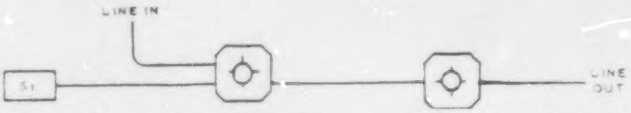
Exercise 27. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out, using 4 pieces of ½-inch thinwall conduit, indoor conductors of proper length and colors, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 1 handy box, 1 single-pole switch, 1 handy box cover for toggle switch, 4 connectors for ½-inch thinwall conduit and 1 coupling for ½-inch thinwall conduit.

Situation 28. A light is needed near the automatic feeder controls and poultry light timer in the laying house. This light is to be controlled by a switch mounted on the wall.



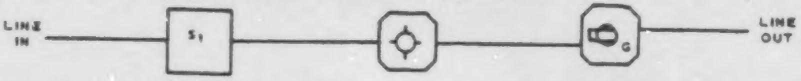
Exercise 28. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out, using 3 pieces of UF cable with bare ground, 1 handy box, 1 four-inch square box, 1 four-inch square keyless lampholder, 1 single-pole switch, 1 handy box cover for toggle switch, and 4 cable connectors.

Situation 29. Two overhead lights are needed in an open front cattle shed. The lights are to be controlled by a switch mounted on the wall.



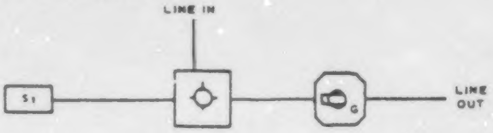
Exercise 29. Wire two keyless lampholders controlled by a single-pole switch with a line in at one light and out at the other, using 4 pieces of UF cable with bare ground, 1 four-inch octagon box with clamps, 1 four-inch octagon box, 1 four-inch octagon box extension, 2 four-inch porcelain keyless lampholders, 1 handy box, 1 single-pole switch, 1 handy box cover for toggle switch, and 3 cable connectors.

Situation 30. A light and a receptacle are needed in the garage. The light should be controlled by a switch but the receptacle should be unswitched.



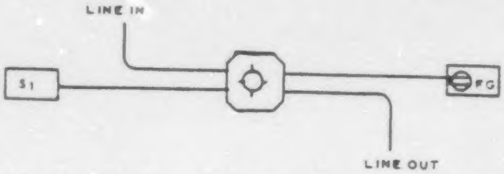
Exercise 30. Wire a keyless lampholder controlled by a single-pole switch with an unswitched duplex receptacle and an unswitched line in at the switch and out at the duplex receptacle, using 4 pieces of NM cable with bare ground, 1 four-inch octagon box, 1 four-inch octagon box with clamps, 1 four-inch porcelain keyless lampholder, 1 four-inch square box, 1 single-pole switch, 1 four-inch square box cover for toggle switch, 1 grounding type duplex receptacle for four-inch octagon box, and 4 cable connectors.

Situation 31. A light and receptacle are needed in the equipment storage area in the central laying house. The light should be controlled by a switch mounted on the wall but the receptacle is to be unswitched.



Exercise 31. Wire a keyless lampholder controlled by a single-pole switch with an unswitched duplex receptacle, with a line in at the lampholder and out at the receptacle, using 4 pieces of NM cable with bare ground, 1 handy box, 1 four-inch octagon box, 1 four-inch square box, 1 four-inch square keyless lampholder, 1 single-pole switch, 1 handy box cover for toggle switch, 1 grounding type duplex receptacle for four-inch octagon box, and 6 cable connectors.

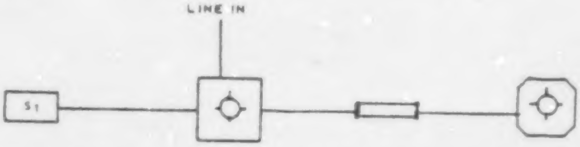
Situation 32. A light and fused grounding type receptacle are needed in the farm shop. The light should be controlled by a switch near the door but the fused receptacle is to be unswitched for the stationary air compressor.



Exercise 32. Wire a keyless lampholder controlled by a single-pole switch with an unswitched line in and out at the light and an unswitched fused grounding receptacle, using 4 pieces of NM cable with bare ground, 1 four-inch octagon box with cable clamps, 1 four-inch octagon box extension ring, 2 handy boxes, 1 four-inch porcelain keyless lampholder, 1 single-pole switch, 1 handy box cover for toggle switch, 1 fused single grounding receptacle, and 2 cable connectors.

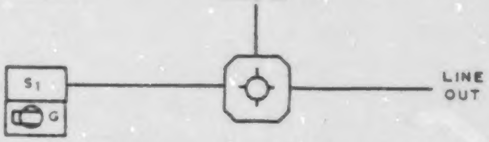
4. MORE DIFFICULT WIRING EXERCISES

Situation 33. A light is needed in the haymow with a pilot light below to indicate when the haymow light is turned on.



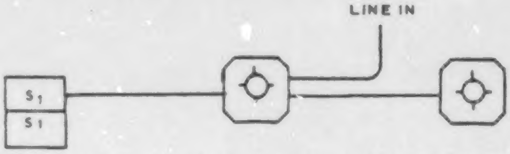
Exercise 33. Wire a haymow light with a pilot light, with an unswitched line in at the pilot light, using 3 pieces of NM cable with ground, 1 four-inch square box, 1 four-inch square keyless lampholder, 1 four-inch octagon box with clamps, 1 four-inch porcelain keyless lampholder to simulate haymow light, 1 handy box, 1 single-pole switch, 1 handy box cover for toggle switch, 1 piece of ½" rigid conduit to simulate protecting the cable where it passes through haymow floor and up beyond the height of the hay, 2 bushings for ½" conduit, and 4 cable connectors.

Situation 34. A light is needed in the entryway in the house. This light is to be controlled by a switch located beside the door. The switch is to be ganged with a duplex receptacle that is not switched.



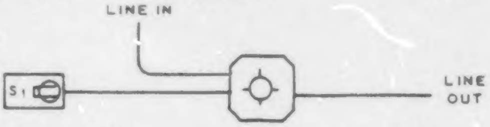
Exercise 34. Wire a keyless lampholder controlled by a single-pole switch, an unswitched duplex receptacle ganged with the single-pole switch, with an unswitched line in and out, using 3 pieces of NM cable with ground, 1 four-inch octagon box, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder to represent a fixture, 2 conduit switch boxes $2\frac{1}{2}$" deep, 1 single-pole switch, 1 grounding type duplex receptacle, 1 two-gang plate for toggle switch and receptacle, and 4 cable connectors.

Situation 35. A light is needed in the furnace room and another in the laundry room. These lights are to be controlled by separate switches ganged together and mounted in the wall at the top of the basement stairs.



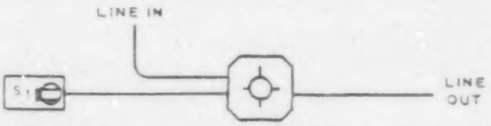
Exercise 35. Wire two keyless lampholders, each controlled by a single-pole switch with the switches ganged together, with an unswitched line in, using 3 pieces of NM cable with ground, 2 four-inch octagon boxes with clamps, 1 four-inch octagon box extension, 2 porcelain keyless lampholders, 2 conduit switch boxes $2\frac{1}{2}$" deep, 2 single-pole switches, 1 two-gang plate for toggle switches, and 1 cable connector.

Situation 36. A light is needed in the attic. A receptacle is needed next to the attic stairs where the attic light switch is to be located.



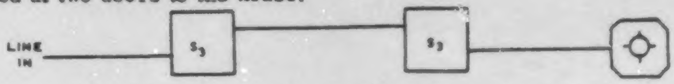
Exercise 36. Wire a keyless lampholder controlled by a single-pole switch in combination with a single unswitched receptacle, with an unswitched line in and out, using 3 pieces of NM cable with ground, 1 four-inch octagon box with clamps, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder, 1 conduit switch box $2\frac{1}{2}$" deep, 1 combination single-pole switch and receptacle, 1 bakelite wall plate for switch and receptacle, and 1 cable connector.

Situation 37. A light is needed in the laundry room. To prevent the iron from heating while no one is using the room, the switch that controls the light should also control a receptacle.



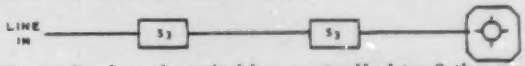
Exercise 37. Wire a keyless lampholder controlled by a single-pole switch in combination with a single receptacle, the receptacle also controlled by the switch, with an unswitched line in and out, using 3 pieces of NM cable with ground, 1 four-inch octagon box with clamps, 1 four-inch octagon box extension, 1 four-inch keyless lampholder, 1 conduit switch box $2\frac{1}{2}$" deep, 1 combination single-pole switch and receptacle, 1 bakelite wall plate for switch and receptacle, and 1 cable connector.

Situation 38. A light is needed in the farrowing house. The light is to be controlled by switches located at two doors to the house.



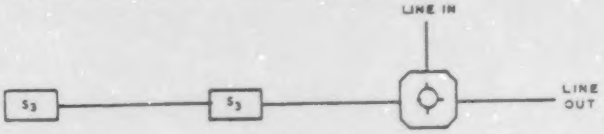
Exercise 38. Wire a keyless lampholder controlled by 2 three-way switches, the switches being located between the source and the light, using 3 pieces of UF cable with ground, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 2 four-inch square boxes, 2 three-way switches, 2 four-inch square box covers for toggle switch, and 5 cable connectors.

Situation 39. A light is needed in the laying house. This light is to be controlled by switches located at two doors to the house.



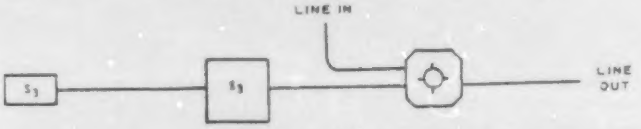
Exercise 9. Wire a keyless lampholder controlled by 2 three-way switches, the switches being located between the source and the light, using 3 pieces of $\frac{1}{2}$-inch thinwall conduit, individual conductors of proper length and colors, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 2 handy boxes, 2 three-way switches, 2 handy box covers for toggle switch, and 5 connectors for $\frac{1}{2}$-inch thinwall conduit.

Situation 40. A light is needed over the grain dump in the corn crib. This light is to be controlled by switches located at each end of the driveway.



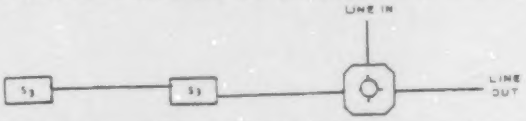
Exercise 40. Wire a keyless lampholder controlled by 2 three-way switches, the light being located between the source and the switches, with an unswitched line in and out, using 4 pieces of $\frac{1}{2}$-inch thinwall conduit, individual conductors of proper length and colors, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 2 handy boxes, 2 three-way switches, 2 handy box covers for toggle switch, and 6 connectors for $\frac{1}{2}$-inch thinwall conduit.

Situation 41. A light is needed near the timer for the automatic feeder in the cattle feeding shed. This light is to be controlled by switches located at each end of the shed.



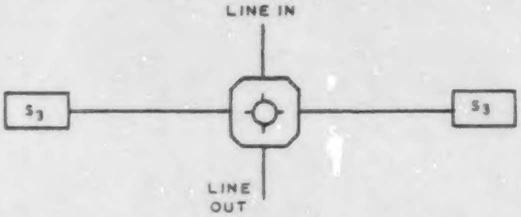
Exercise 41. Wire a keyless lampholder controlled by 2 three-way switches, the light being located between the source and the switches with an unswitched line in and out, using 4 pieces of UF cable with ground, 1 four-inch octagon box with cable clamps, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder, 1 four-inch square box, 1 handy box, 2 three-way switches, 1 four-inch square box cover for toggle switch, 1 handy box cover for toggle switch, and 3 cable connectors.

Situation 42. A light is to be located in the center of the utility room. The light is to be controlled by two switches, each located beside an entry door.



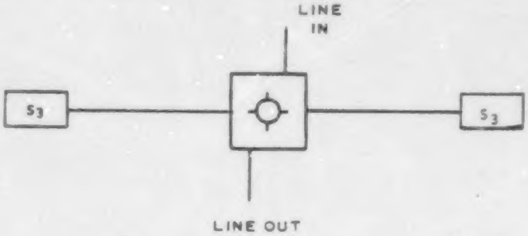
Exercise 42. Wire a keyless lampholder controlled by 2 three-way switches, the light being located between the source and the switches, with an unswitched line in and out, using 4 pieces of NM cable with bare ground, 1 conduit switch box $2\frac{1}{2}$ inches deep, 1 $3\frac{1}{2}$-inch deep switch box with cable clamps, 1 four-inch octagon box, 1 four-inch keyless porcelain lampholder, 1 four-inch octagon box extension ring, 2 three-way switches, 2 bakelite wall plates for toggle switch, and 4 cable connectors.

Situation 43. A light is needed in the center of the milking parlor. This light is to be controlled by switches located at both ends of the parlor.



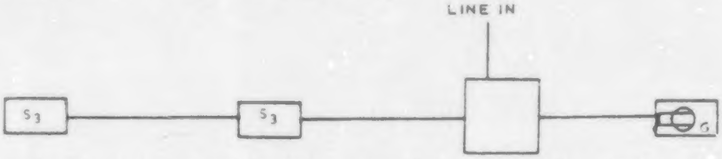
Exercise 43. Wire a keyless lampholder controlled by 2 three-way switches, the source and light being located between the switches, with an unswitched line in and out, using 4 pieces of UF cable with ground, 1 four-inch octagon box, 1 four-inch octagon box extension, 1 four-inch porcelain keyless lampholder, 2 handy boxes, 2 three-way switches, 2 handy box covers for toggle switch, and 6 cable connectors.

Situation 44. A light is to be located in the center of the farrowing house. This light is to be controlled by switches located at both ends of the building.



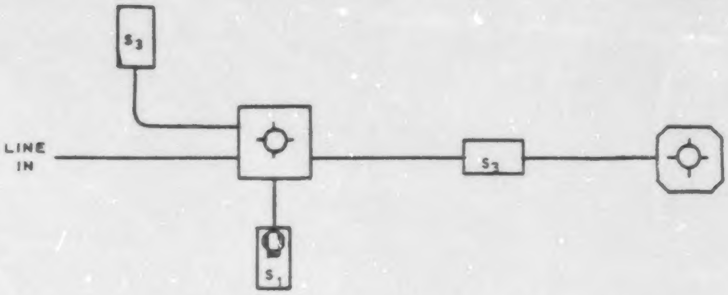
Exercise 44. Wire a keyless lampholder controlled by 2 three-way switches, the source and light being located between the switches, with an unswitched line in and out, using 4 pieces of UF cable with ground, 1 four-inch square box, 1 four-inch square box extension, 1 four-inch square keyless lampholder, 2 handy boxes, 2 three-way switches, 2 handy box covers for toggle switch, and 6 cable connectors.

Situation 45. A duplex receptacle is needed in the living room that will have one outlet (for a television receiver) unswitched and the other outlet (for a floor lamp) controlled by switches mounted in the wall next to the doors.



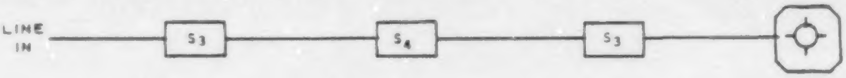
Exercise 45. Wire a duplex receptacle with one outlet switched and the other unswitched with the unswitched line located between the switches and the receptacle, using 4 pieces of NM cable with ground, 1 four-inch square box, 1 four-inch square blank cover, 1 conduit switch box $3\frac{1}{2}$" deep, 2 conduit switch boxes $2\frac{1}{2}$" deep, 2 three-way switches, 2 bakelite wall plates for toggle switch, 1 split grounding type duplex receptacle, 1 bakelite wall plate for duplex receptacle, and 6 cable connectors.

Situation 46. A light is needed in the upstairs hall that can be controlled by switches mounted in the wall next to each end. The light in the linen closet is controlled by a switch wired in combination with an unswitched receptacle for vacuum sweeper.



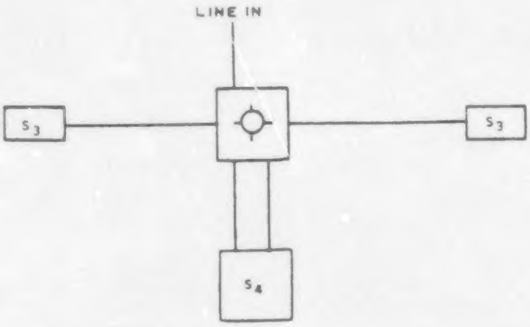
Exercise 46. Wire two keyless lampholders, one controlled by a single-pole switch in combination with a single unswitched receptacle, the other controlled by 2 three-way switches, using 5 pieces of NM cable with ground, 1 four-inch square box, 1 four-inch square box extension, 1 four-inch square keyless lampholder, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 2 conduit switch boxes 2½" deep, 1 conduit switch box 3½" deep, 2 three-way switches, 2 bakelite wall plates for toggle switches, 1 combination switch and receptacle, 1 bakelite wall plate for combination switch and receptacle, and 8 cable connectors.

Situation 47. A light is needed in the farm shop that can be controlled by switches located at either large door and the small walk-in door.



Exercise 47. Wire a keyless lampholder controlled by 1 four-way and 2 three-way switches, the switches being located between the source and the light, using 4 pieces of ½-inch thinwall conduit, individual conductors of proper length and colors, 1 four-inch octagon box, 1 four-inch porcelain keyless lampholder, 3 handy boxes, 2 three-way switches, 1 four-way switch, 3 handy box covers for toggle switch, and 7 connectors for ½-inch thinwall conduit.

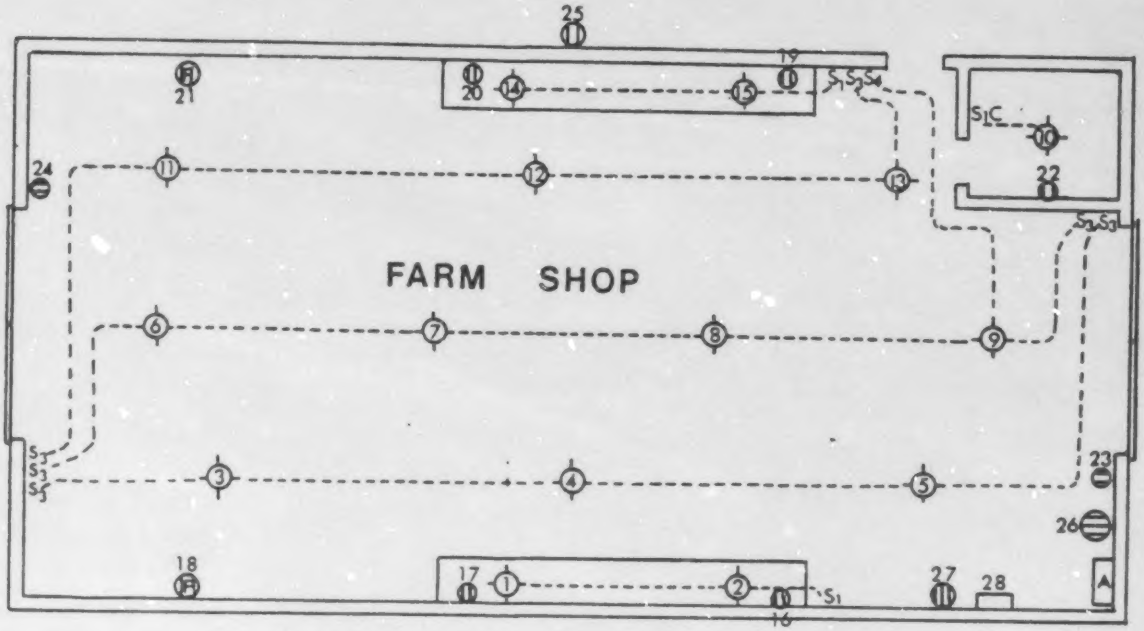
Situation 48. The farm shop has a large door at each end and a walk-in door on one side. A light is needed that can be controlled by switches mounted on the wall next to each doorway.



Exercise 48. Wire a keyless lampholder controlled by 1 four-way and 2 three-way switches, using 5 pieces of NM cable with ground, 2 four-inch square boxes, 1 four-inch square box extension, 1 four-inch square keyless lampholder, 2 handy boxes, 2 three-way switches, 1 four-way switch, 2 handy box covers for toggle switch, 1 four-inch square box cover for toggle switch, and 9 cable connectors.

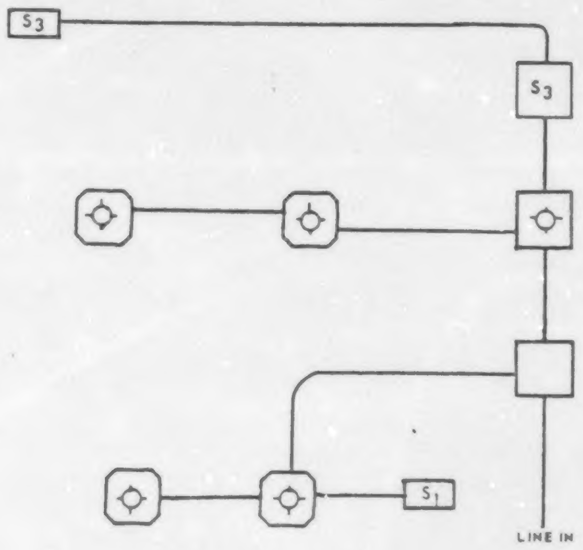
5. GROUP EXERCISE

Situation. A new farm shop is to be wired according to the plan shown.

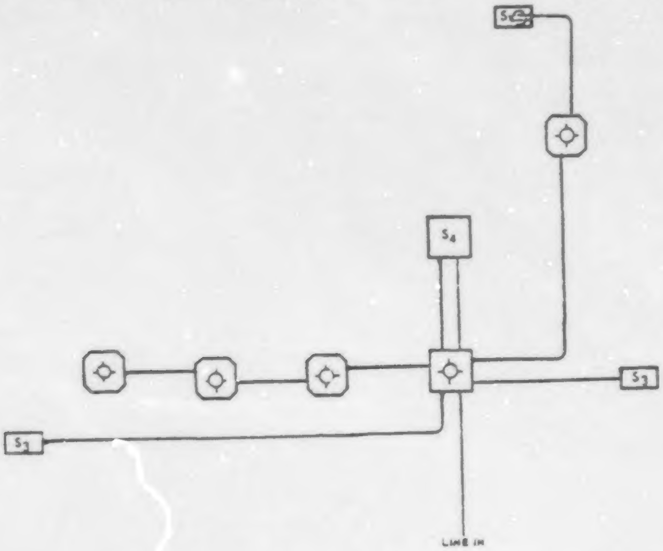

FARM SHOP
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
A
S_1
S_3
S_3
S_3
S_1
S_3
S_4
S_1C
S_3
S_3

Group Exercise. Follow the proposed wiring layout and connect each of the circuits into the main circuit breaker box, A.

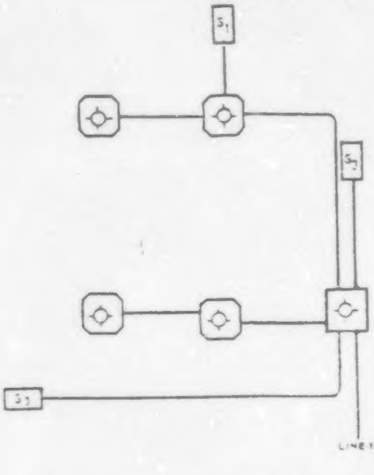
Circuit No. 1. Lights 1, 2, 3, 4, and 5. Wire 2 keyless lampholders over the south workbench controlled by a single-pole switch at one end of the bench, and 3 keyless lampholders controlled by 2 three-way switches, one beside each of the large doors, using nonmetallic cable with bare ground, 3 four-inch square boxes, 2 four-inch octagon boxes, 2 four-inch octagon boxes with clamps, 4 four-inch porcelain keyless lampholders, 1 four-inch square keyless lampholder, 1 four-inch square blank cover, 2 handy boxes, 2 three-way switches, 1 single-pole switch, 2 handy box covers for toggle switch, 1 raised cover for square box for toggle switch, and 15 cable connectors.


S_3
S_3
S_1
LINE IN

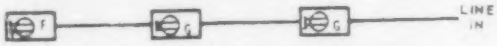
Circuit No. 2. *Lights* 6, 7, 8, 9, and 10. Wire 4 keyless lampholders controlled by three-way switches at each of the large doors and 1 four-way switch near the small door, and 1 keyless lampholder in the northeast corner room controlled by a single-pole switch in combination with a single unswitched grounding receptacle, using nonmetallic cable with bare ground, 2 four-inch square boxes, 1 four-inch square box extension ring, 1 four-inch octagon box, 3 four-inch octagon boxes with clamps, 4 four-inch porcelain keyless lampholders, 1 four-inch square keyless lampholder, 2 handy boxes, 1 switch box $2\frac{1}{2}$ inches deep, 2 three-way switches, 1 four-way switch, 1 combination single-pole switch and receptacle, 2 handy box covers for toggle switch, 1 four-inch square raised cover for toggle switch, 1 bakelite wall plate for toggle switch, and 14 cable connectors.



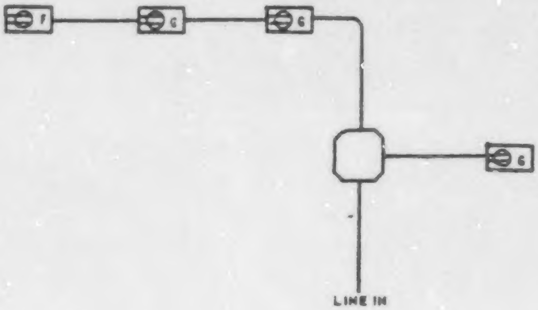
Circuit No. 3. Lights 11, 12, 13, 14, and 15. Wire 3 keyless lampholders controlled by 1 three-way switch at the west large door and 1 three-way switch at the small door, and 2 keyless lampholders over the north workbench controlled by a single-pole switch near the small door, using nonmetallic cable with bare ground, 1 four-inch square box, 1 four-inch square box extension ring, 3 four-inch octagon boxes, 1 four-inch octagon box with clamps, 4 four-inch porcelain keyless lampholders, 1 four-inch square keyless lampholder, 3 handy boxes, 2 three-way switches, 1 single-pole switch, 3 handy box covers for toggle switch, and 14 cable connectors.



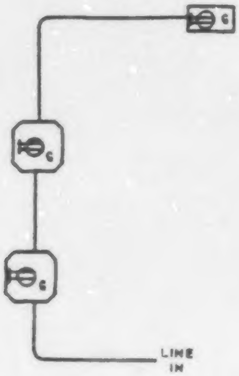
Circuit No. 4. Duplex receptacles 16 and 17 over south workbench and single fused receptacle 18 farther west on south wall. Wire 2 grounding duplex receptacles and 1 single grounding fused receptacle, using nonmetallic cable with bare ground, 3 handy boxes, 2 grounding duplex receptacles, 1 single grounding fused receptacle, 2 handy box covers for duplex receptacle, and 6 cable connectors.



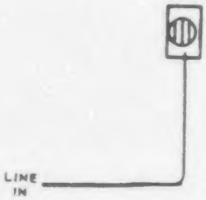
Circuit No. 5. Duplex receptacles 19 and 20 over north workbench, single fused receptacle 21 farther west on north wall, and duplex receptacle 22 in northeast corner room. Wire 3 grounding duplex receptacles and 1 single grounding fused receptacle, using nonmetallic cable with bare ground, 1 four-inch octagon box, 1 four-inch blank cover, 3 handy boxes, 1 bevel corner switch box, 3 grounding duplex receptacles, 1 single grounding fused receptacle, 2 handy box covers for duplex receptacle, 1 bakelite wall plate for duplex receptacle, and 9 cable connectors.



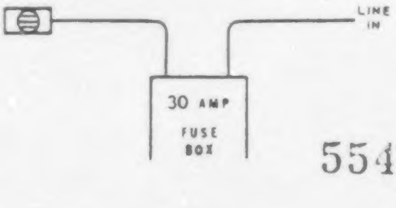
Circuit No. 6. Duplex receptacle 23 near east large door, duplex receptacle 24 near west large door, and single outdoor receptacle 25 outside on north wall, all protected by ground-fault interruptor. Wire 2 grounding duplex receptacles and 1 single grounding outdoor receptacle using UF cable with bare ground, 2 four-inch octagon boxes, 2 grounding duplex receptacles for octagon box, 1 cast box with single grounding receptacle and cover for outdoor use, and 6 cable connectors.



Circuit No. 7. Range receptacle 26 for arc welder on east wall, south of large door. Wire a range receptacle using service entrance cable, 1 surface-mounted range receptacle, and 1 3/4-inch non-weatherproof service cable connector.



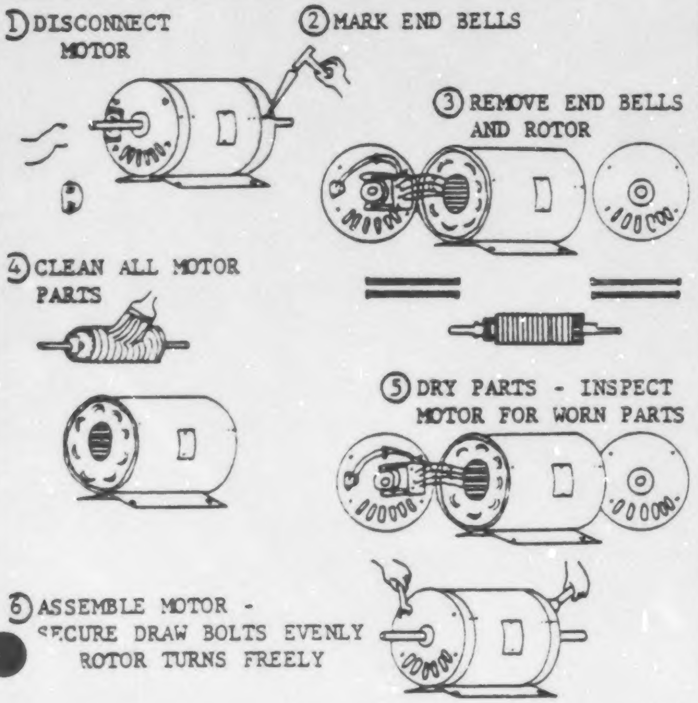
Circuit No. 8. Single polarized 240-volt receptacle controlled and protected by 30-ampere fused switch, located on south wall, near southeast corner. Wire a single polarized 240-volt receptacle controlled by a 30-ampere fused switch, using nonmetallic cable with bare ground, 1 30-ampere two-fuse switch with solid neutral, 1 handy box, 1 single polarized 240-volt receptacle, 1 handy box cover for single receptacle, and 4 cable connectors.



DEPARTMENT OF AGRICULTURAL EDUCATION
THE PENNSYLVANIA STATE UNIVERSITY
TAH 566

AgIII-IV-151

CLEANING AND SERVICING AN ELECTRIC MOTOR



① DISCONNECT MOTOR
② MARK END BELLS
③ REMOVE END BELLS AND ROTOR
④ CLEAN ALL MOTOR PARTS
⑤ DRY PARTS - INSPECT MOTOR FOR WORN PARTS
⑥ ASSEMBLE MOTOR - SECURE DRAW BOLTS EVENLY ROTOR TURNS FREELY

Materials

1. An electric motor needing to be cleaned and serviced
2. Tools for disassembling an electric motor
3. A paint brush, motor cleaning solvent and pan to wash parts

Operation Teaches (Ability to . . .
(Understanding of . . .

1. A. disconnect a motor from an electrical source
2. A. correctly mark motor frame and end bells
3. U. importance of carefully removing the end bells so as to not damage leads or motor windings
4. A. remove rotor from motor without damaging the centrifugal switch or motor brushes
5. U. correct type solvent to use in cleaning an electric motor
6. A. thoroughly clean and dry all motor parts
7. A. identify and inspect parts for wear or damage
8. A. reassemble motor parts in reverse order of disassembly and tighten end bell bolts
9. A. lubricate motor using correct type & amount of lubrication
10. A. connect motor to power source

Operational Procedure

1. Disconnect motor leads at terminal cover plate. Note position of leads on terminals
2. Remove motor from mount or machine
3. Wipe all dirt from outside of motor
4. Mark end bells with center punch-one mark on end bell and stator frame on terminal connection end. Use 2 marks on other end
5. Remove end bell bolts
6. Using a wood block or soft-faced hammer remove end bell containing starting switch or brush ring
7. Remove rotor and other end bell
8. Clean all motor parts with motor solvent. Do not use gasoline. Use carbon tetrachloride only in a well ventilated area. Avoid soaking the windings or leads
9. Dry all parts with a cloth or compressed air
10. Identify and examine all parts for wear, damage or loose connections-make necessary repairs
11. Reassemble motor in reverse to disassembly. Tighten end bell bolts evenly checking to see that the rotor turns freely

Lubricate motor bearings with #10 oil or grease depending upon type

13. Mount motor and connect electrical leads-try motor by throwing switch

Evaluation Score Sheet

Item	Points Possible	Points Earned
1. Correctly disconnecting motor from electrical source-mark leads	5	______
2. Correctly marking end bells	5	______
3. Carefully removing end bells in correct order	10	______
4. Selecting correct solvent for cleaning motor	5	______
5. Thorough cleaning and drying of motor parts	15	______
6. Inspection and identification of parts-make repairs	20	______
7. Correct reassembling of motor, rotor free to turn	10	______
8. Proper type and amount of lubrication used on motor	10	______
9. Connecting motor to power source-motor runs properly	10	______
10. Work habits and attitude	10	______
Total points	100	______

Name ____________________

Date ____________ Grade ____________

CIRCUIT SURVEY

Building ____________________

Circuit Number or Name	Wire Size	Size of Protection Device
____________	________ AWG	____________ Amps.

Electrical Load on Circuit

Item	Watts	
Total Watts		
Maximum watts for size of wire		
Difference + or −		
Will maximum protective device carry load?	☐ Yes	☐ No
Is circuit safe?	☐ Yes	☐ No
Is minimum size protective device being used?	☐ Yes	☐ No
Does circuit have a grounding conductor?	☐ Yes	☐ No

CIRCUIT SURVEY

Building ____________________

Circuit Number or Name	Wire Size	Size of Protection Device
____________	________ AWG	____________ Amps.

Electrical Load on Circuit

Item	Watts	
Total Watts		
Maximum watts for size of wire		
Difference + or −		
Will maximum protective device carry load?	☐ Yes	☐ No
Is circuit safe?	☐ Yes	☐ No
Is minimum size protective device being used?	☐ Yes	☐ No
Does circuit have a grounding conductor?	☐ Yes	☐ No

SURVEY OF ELECTRICAL HAZARDS – RESIDENCES

Yes	No	
GENERAL		
		Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes, and loads for each circuit?
		Have you completed a circuit survey for the residence?
SERVICE EQUIPMENT		
		Is an approved service entrance used?
		Is the ground rod of proper size, type, location?
		Is the ground conductor properly attached to the ground rod?
KITCHEN		
		Are there twp small appliance circuits for the kitchen?
		Are kitchen appliance cords and plugs in good condition, free of cracked insulation, frayed conductors?
		Are there sufficient convenience outlets to prevent using makeshift "cube plugs."
		Are there enough outlets so all appliances can be located within 6 feet of an outlet.
		Are flexible cords used properly, not under rugs or through doorways.
		Are cables in attics and basements protected by guard strips?
		Are cables secured to boxes by connectors or clamps?
		Are critical appliances like furnace and freezer on separate circuits?
LAUNDRY		
		Is washer on a GFCI protected circuit?
		Are receptacles for laundry appliances located so extension cords need not be used?
		Are laundry appliances grounded?
BATHROOM		
		Are receptacles in the bathrooms, workshop, hobby area, and garage protected by GFCI's?
		Are power tools equipped with 3-wire grounding cords (or double insulated)?
		Are conductors on power equipment in good condition?
OUTDOOR PATIO AREAS		
		Are outdoor receptacles protected by GFCI's?

SURVEY OF ELECTRICAL HAZARDS – BEEF ENTERPRISE

Yes	No	
GENERAL		
____	____	Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes and loads for each circuit?
____	____	Have you completed a circuit survey for the beef building and equipment?
____	____	Do you have a map showing location of underground conductors?
SERVICE EQUIPMENT		
____	____	Is an approved service entrance used?
____	____	Is service equipment mounted on fire resistant panel?
____	____	Does the building have a main service disconnect?
____	____	Is the service entrance properly grounded?
____	____	Is electrical service disconnect, circuit distribution box in a separate dust-free room?
____	____	Are spare fuses available of the proper size?
WIRING		
____	____	Are conductors located so they are not damaged by cattle or equipment?
____	____	Are conductors properly protected and secured?
____	____	Are boxes and fittings in damp areas of proper type?
____	____	Do circuits include grounding conductors?
____	____	Are boxes, covers, conduit free from corrosion?
EQUIPMENT		
____	____	Are water pumps checked regularly?
____	____	Is water supply heater properly grounded?
OTHER		
____	____	
____	____	
____	____	
____	____	
____	____	

SURVEY OF ELECTRICAL HAZARDS – GRAIN AND FEED HANDLING

Yes	No	
		GENERAL
____	____	Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes and loads for each circuit for each building?
____	____	Has circuit survey been completed for each building?
____	____	Is there a map showing location of underground conductors?
		SERVICE EQUIPMENT
____	____	Is approved service entrance used?
____	____	Does building have main service disconnect?
____	____	Is service entrance properly grounded?
____	____	Are spare fuses available? of proper size?
____	____	Are breakers free of evidence of corrosion?
____	____	Is service equipment in dust-free room?
		MOTORS
____	____	Is protective device small enough to protect the motor?
____	____	Are motors cleaned regularly so they do not overheat?
____	____	Are motors running within temperature specified on nameplate?
____	____	Are motors free from excessive bearing wear?
____	____	Are motors lubricated according to recommendations?
____	____	Do motors have thermal overload protection?
____	____	Are motor mounts secure, free of vibration?
____	____	Are control devices normal temperature?
____	____	Are motor circuits protected with time delay fuses?
____	____	Are belts, pulleys, chains, and shafts protected?
		LIGHTING
____	____	Are lights protected by dust-tight globes and fixtures?
____	____	Are conductors in conduit protected from rodent damage?
____	____	Are splices and connections in covered boxes?
____	____	Are lights free from accumulations of dust and dirt?
		OTHER
____	____	
____	____	

AgIII-IV-158

SURVEY OF ELECTRICAL HAZARDS – GREENHOUSES

Yes No

GENERAL

____ ____ Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes and loads for each circuit?

____ ____ Has a circuit survey been completed for each building?

____ ____ Is there a map available showing location of underground conductors?

SERVICE EQUIPMENT

____ ____ Is an approved service entrance used?

____ ____ Is service equipment mounted on a fire resistant panel?

____ ____ Does the building have a main service disconnect?

____ ____ Is service entrance properly grounded?

____ ____ If fuses are used, are spare fuses available of the proper size?

____ ____ Are circuit breakers operable, free of corrosion?

WIRING

____ ____ Are all electrical receptacles waterproof?

____ ____ Are greenhouse circuits protected with Ground Fault Interrupters?

____ ____ Are all switches in greenhouse waterproof?

____ ____ Are all hookups done with permanent wiring, not extension cords?

____ ____ Are all circuits equipped with grounding conductors?

____ ____ Are all portable tools double insulated?

____ ____ Are all portable tools equipped with a grounding conductor and a 3-prong plug?

MOTORS

____ ____ Are protective devices small enough to protect motors?

____ ____ Are motors cleaned regularly so they do not overheat?

____ ____ Are motors free from excessive bearing wear?

____ ____ Are motors lubricated according to manufacturers recommendations?

____ ____ Do motors have automatic thermal overload protection?

____ ____ Are all motors grounded?

____ ____ Are motors free from excessive vibration?

____ ____ Are driven belts, chains, gears, and shafts protected?

LIGHTING

____ ____ Is insulation on conductors in good condition?

____ ____ Are lights located so they are not subject to breakage damage by workers or equipment?

____ ____ Are circuits turned off when bulbs are cleaned or replaced?

____ ____ Are all light bulbs in waterproof enclosures?

EQUIPMENT

____ ____ Are water pumps checked regularly for electrical hazards?

____ ____ Are ventilating fans checked and cleaned regularly?

____ ____ Are thermostats checked for proper operation?

____ ____ Are motor controllers in waterproof enclosures?

____ ____ Are noisy relays checked?

____ ____ Are switches and equipment free of rust and corrosion?

STAND-BY GENERATOR

____ ____ Is generator started regularly to check operation?

____ ____ Is transfer switch of proper type?

SURVEY OF ELECTRICAL HAZARDS — POULTRY ENTERPRISE

Yes	No	
GENERAL		
____	____	Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes and loads for each circuit?
____	____	Have you completed a circuit survey for all the poultry buildings?
____	____	Do you have a map showing location of underground conductors?
SERVICE EQUIPMENT		
____	____	Is an approved service entrance used?
____	____	Is service equipment mounted on fire resistant panel?
____	____	Does the building have a main service disconnect?
____	____	Is the service entrance properly grounded?
____	____	Is electrical service disconnect, circuit distribution box in a separate dust-free room.
____	____	Are spare fuses available of the proper size?
EQUIPMENT		
____	____	Are water pumps checked regularly?
____	____	Are ventilating fans checked regularly?
____	____	Do thermostats operate correctly?
____	____	Are motor controllers in dust-tight enclosures?
____	____	Are noisy relays replaced?
____	____	Are switches free from rust and corrosion?
STAND-BY GENERATOR		
____	____	Does generator start when needed?
____	____	Is the transfer switch of the proper type?
MOTORS		
____	____	Is protective device small enough to protect the motor?
____	____	Are motors cleaned regularly so they do not overheat?
____	____	Are motors free from excessive bearing wear?
____	____	Are motors lubricated according to recommendations?
____	____	Are belts in satisfactory condition?
____	____	Do motors have automatic thermal overhead protection?
____	____	Are motor mounts free from vibration?
____	____	Are all motors grounded?
____	____	Are belts, chains, gears, and shafts guarded?
WIRING AND LIGHTING		
____	____	Is insulation on conductors in good condition?
____	____	Are conductors properly protected and secured?
____	____	Are all splices and connections enclosed in covered boxes?
____	____	Are boxes and fittings in damp areas of the proper type?
____	____	Are lights properly protected from dust and breakage?
____	____	Do circuits include grounding conductors?
____	____	Are boxes, covers and conduit free from corrosion?
____	____	Are lights free from accumulation of dust and dirt?
____	____	Are bulbs all burning?
OTHER		
____	____	
____	____	

SURVEY OF ELECTRICAL HAZARDS – SHOP AND STORAGE FACILITIES

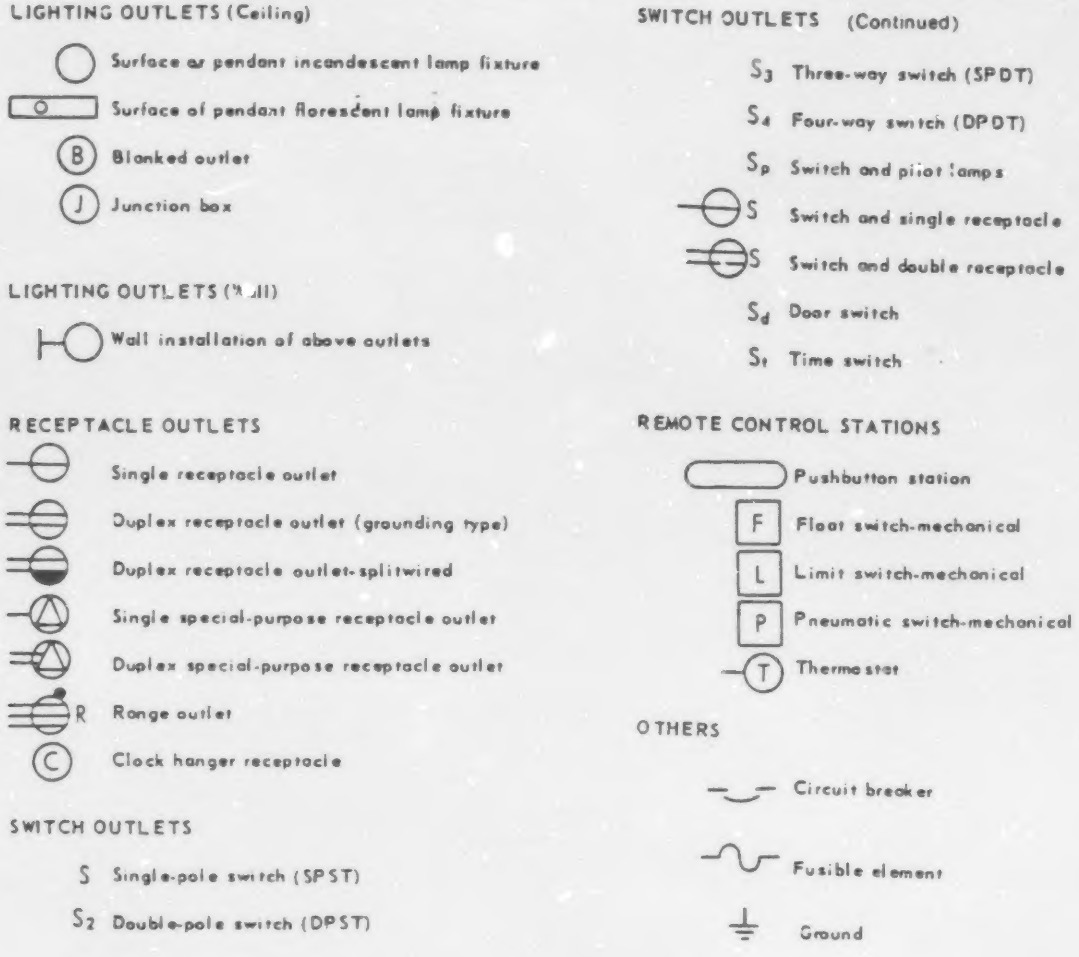
Yes	No	
		GENERAL
____	____	Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes and loads for each circuit?
____	____	Has a circuit survey been completed from each circuit?
____	____	Is there a map showing location of underground conductors?
		SERVICE
____	____	Is an approved service entrance used?
____	____	Is there a main service disconnect?
____	____	Is the service entrance properly grounded?
____	____	If fused, are spare fuses of proper size available?
____	____	Are circuit breakers free of corrosion?
		WIRING
____	____	Are conductors located so they are not damaged by equipment?
____	____	Are conductors properly secured?
____	____	Are circuits protected by GFCI's where user is apt to be grounded while using electric powered equipment?
____	____	Are boxes and fittings in damp areas of proper type?
____	____	Do circuits have grounding conductors?
____	____	Is insulation on conductors in good condition?
____	____	Are splices and connections enclosed in covered boxes?
____	____	Are there sufficient outlets so "cube plugs" are not needed?
____	____	Are there sufficient circuits so extension cords are not needed for permanent wiring?
____	____	Are extension cords 3-wire with approved grounding attachment plugs?
____	____	Are cables secured to boxes by connectors or clamps?
		EQUIPMENT
____	____	Is electrical equipment free from combustible materials?
____	____	Are power tools equipped with 3-wire grounding leads (if not double insulated)?
____	____	Are cords and plugs on power tools in good condition?
____	____	Is the water heater properly grounded?
____	____	Are ventilating fans free of dust?
____	____	Are motor drive belts in satisfactory condition?
____	____	Are major items of electrical equipment wired separately, and properly fused?
		LIGHTING
____	____	Are lights properly protected from breakage and dust?
____	____	Are lights free from accumulations of dust?
		MOTORS
____	____	Do unattended motors (air compressor, etc.) have an automatic thermal overload protection device?
____	____	Where the motors are fused separately, is the time delay fuse the minimum size to protect both the motor and the conductor?
____	____	Are motors located in dusty areas properly cleaned?
____	____	Are motors free from excessive bearing wear?
____	____	Are motors lubricated according to manufacturer's recommendations?
____	____	Are motors free of vibrations?
____	____	Are all motors grounded?
____	____	Are motor driven belts, chains, gears, and shafts guarded?

SURVEY OF ELCTRICAL HAZARDS – SWINE FACILITIES

Yes	No	
		GENERAL
____	____	Is there a wiring diagram showing circuits, wire size, controls, switches, junction boxes and loads for each circuit for each swine building?
____	____	Have you completed a circuit survey for the building?
____	____	Do you have a farmstead map showing location of underground conductors?
		EQUIPMENT
____	____	Are water pumps checked regularly?
____	____	Are ventilating fans checked regularly? cleaned regularly?
____	____	Do thermostats operate correctly?
____	____	Are noisy relays replaced?
____	____	Are switches free from rust and corrosion?
		STAND-BY GENERATOR
____	____	Does generator start when needed?
____	____	Is the transfer switch of the proper type?
		SERVICE EQUIPMENT
____	____	Is an approved service entrance used?
____	____	Does the building have a main service disconnect?
____	____	Is the service entrance properly grounded?
____	____	Are motor circuits protected with time-delay fuses or breakers?
____	____	Are spare fuses available? of the proper size?
____	____	Are breakers free of evidence of corrosion?
____	____	Is electrical service disconnect, circuit distribution box in a separate dust-free room?
		WIRING AND LIGHTING
____	____	Is insulation on conductors in good condition? free of rodent damage?
____	____	Are conductors properly protected and secured?
____	____	Are all splices and connections enclosed in covered boxes?
____	____	Are boxes and fittings in damp areas of the proper type?
____	____	Are lights properly protected from dust and breakage?
____	____	Do circuits include grounding conductors?
____	____	Are boxes, covers and conduit free from corrosion?
____	____	Are lights free from accumulation of dust and dirt?
____	____	Are bulbs all burning?
____	____	Are controls and wiring for radiant heaters safe?
		MOTORS
____	____	Is protective device small enough to protect the motor?
____	____	Are motors cleaned regularly so they do not overheat?
____	____	Are motors free from excessive bearing wear?
____	____	Are motors lubricated according to recommendations?
____	____	Are belts in satisfactory condition?
____	____	Do motors have automatic thermal overload protection?
____	____	Are motor mounts free from vibration?
		HEAT LAMPS
____	____	Are heat lamps made of Pyrex glass?
____	____	Are heat lamps protected by a shield and bail?
____	____	Are heat lamps hung by a chain or wire (not the cord)?
____	____	Is cord on heat lamp short enough so it will unplug should it fall to the floor?
____	____	Are there no more than 7-250W lamps or 9-150W lamps on No. 12AWG circuit?
____	____	Are there no more than 5-250W lamps or 7-150W lamps on No. 14AWG circuit?
____	____	Are heat lamps out of reach of hogs so they cannot chew on cord?

Appendix D

GRAPHIC ELECTRICAL SYMBOLS FOR FARM WIRING PLANS



LIGHTING OUTLETS (Ceiling)

- Surface or pendant incandescent lamp fixture
- Surface of pendant florescent lamp fixture
- Ⓑ Blanked outlet
- Ⓙ Junction box

LIGHTING OUTLETS (Wall)

- Wall installation of above outlets

RECEPTACLE OUTLETS

- Single receptacle outlet
- Duplex receptacle outlet (grounding type)
- Duplex receptacle outlet-splitwired
- Single special-purpose receptacle outlet
- Duplex special-purpose receptacle outlet
- R Range outlet
- Ⓒ Clock hanger receptacle

SWITCH OUTLETS

- S Single-pole switch (SPST)
- S_2 Double-pole switch (DPST)

SWITCH OUTLETS (Continued)

- S_3 Three-way switch (SPDT)
- S_4 Four-way switch (DPDT)
- S_p Switch and pilot lamps
- S Switch and single receptacle
- S Switch and double receptacle
- S_d Door switch
- S_t Time switch

REMOTE CONTROL STATIONS

- Pushbutton station
- F Float switch-mechanical
- L Limit switch-mechanical
- P Pneumatic switch-mechanical
- Ⓣ Thermostat

OTHERS

- Circuit breaker
- Fusible element
- Ground

BEST COPY AVAILABLE

PLUMBING

Instructor's Guide:

1. Read all material presented in this unit before preparing instruction material.
2. Purchase any supplies that may be needed for proper instruction.
3. Purchase or locate any audio-visual materials for additional instruction.
4. Prepare for in-class demonstrations and individual/group skill exercises.

Objectives:

Upon completion of this unit, the student will be able to:

1. Define terms associated with plumbing.
2. Name and give the use of different kinds of pipe.
3. Name advantages and disadvantages of steel pipe, copper and PVC plastic pipe.
4. Identify common pipe fittings.
5. List the reasons for using threading compound.
6. Identify tools used in plumbing.
7. List the reasons for using cutting oil.
8. Identify five common sizes of pipe used in plumbing.
9. Distinguish between bolt and pipe threads.
10. Demonstrate the proper procedures for cutting, reaming, threading and connecting.
11. Cut and fit plastic pipe.
12. Cut, fit and solder copper pipe.

Teaching Aids:

1. Examples of galvanized, copper, plastic and PVC piping.
2. Examples of pipe fittings and valves.
3. Tools used in plumbing.
4. Miter box.
5. Miscellaneous materials for demonstrations:

    cutting oil
    pipe joint compound
    50-50 solder
    non-corrosive solder paste
    pipe materials

6. Laboratory Exercise in pipe fitting - slide and cassette:

    Hobar Publications
    1234 Tiller Lane
    St. Paul, MN 55112

    $39.00 1983 price listing

7. Basic Plumbing Skills - Filmstrips: Hobar Publications

    $70.00 1983 price listing

Student Activities:

1. Participate in plumbing demonstrations.
2. Perform the various plumbing skill exercises.
3. Prepare a section in Ag notebooks for plumbing skills.

References:

1. Modern Agricultural Mechanics by Wakeman 1977
    Interstate Printers and Publisher, Inc.
    Danville, Illinois

2. Basic Plumbing textbook: Hobar Publications
    1234 Tiller Lane
    St. Paul, MN 55112

    $9.80 single copy - 1983 price listing
    $7.35 more than 10 copies

3. Advanced Plumbing Textbook: Hobar Publications I

   $9.80 single copy
   $7.35 more than 10 copies - 1983 price listing

Introduction Ideas:

1. Introduction indicating the need for plumbing.
   a. How to get the water to where you need it
   b. Other alternatives
2. Define plumbing
   a. The flow of water, air, steam or fuel through a pipe
3. Audio-visual materials to introduce plumbing to the students
   a. Sound film
   b. Film strip
   c. Slide/cassette series

Table of Appendices:

1. Appendix A: Plumbing Tools
2. Appendix B: Pipe Fittings
3. Appendix C: Installing Sweat-Type Fittings
4. Appendix D: Cementing of PVC Pressure Pipe
5. Appendix E: Plumbing Exercise

Terms and Definitions:

1. Plumbing: the piping and pipe attachments used to carry water into buildings and to drain away sewage and waste.
2. Soil Pipes: the large pipes used to carry sewage.
3. Fittings: the pieces used to join pipe, to provide openings in pipes and to change the direction of pipes.
4. Trap: a water-sealed bend or chamber in a waste pipe.
5. House Drain: a pipe which carries all the sewage from the house.
6. Stack: a soil, waste or ventilating pipe.
7. Fixtures: the appliances connected to the plumbing.
8. Septic Tank: a tank which receives all the sewage piped into it and allows the process of sewage treatment to take place.
9. Lateral Pipe/Leach Lines: a pipe which drains the liquid from the septic tank to the soil.
10. Pipe Friction: water flow is affected by size, number of turns, distance of travel and gravity, it it is elevated and age. Water flows freely in the center of the pipe while friction occurs on the sides of the pipe. Rust increases friction.
11. Domestic Water: fit for human consumption.
12. Portable Water: found at campgrounds - a sign indicating "Portable Water" and it is fit for human consumption.
13. Irrigation Water: used for irrigating fields. Not the best for human consumption. Water may be irrigated from stream or well.

Plumbing

I. Types of Pipe Used in Plumbing

A. Steel or galvanized

1. Advantages

a. Resists mechanical damage
b. Lasts 30 years if corrosion does not develop
c. Fire resistant

2. Disadvantages

a. Corrosion due to acid, alkaline or hard winter and reduces the flow
b. More skills and equipment are needed for installation or repair

3. Comments

a. More expensive

B. Copper

1. Types of copper

a. Rigid
b. Flexible

2. Advantages for rigid copper

a. Resists corrosion
b. Good appearance
c. Fittings are easily soldered
d. Few tools are needed

3. Disadvantages for rigid copper

a. Acid water carries blue/green stain on fixtures
b. Can be punctured by nails
c. Cost

4. Advantages of flexible copper

a. Resist corrosion
b. Good appearance
c. Few tools are needed
d. Easy to guide
e. More adaptable

5. Disadvantages of flexible copper
    a. Acid water carries blue/green stain on fixtures
    b. Can be punctured by nails
    c. Cost

6. Comments
    a. Copper connected to steel cause electrolysis, corrosion and leakage
    b. Electrolysis is a product of chemical change by passage of electric current

C. Thermoplastic

1. Types of thermoplastic
    a. PE (polyethylene)
    b. PVC (polyvinylchloride)

2. Advantages of PE
    a. Low cost
    b. Ease of installation
    c. less friction loss than metal
    d. Light weight

3. Disadvantages of PE
    a. Exposure to sunlight will deteriorate it
    b. Cannot use with high temperature
    c. Fittings go inside of pipe
    d. More easily damaged

4. Comments
    a. Used for irrigation
    b. Used for small watering systems

5. Advantages of PVC
    a. Long life expectancy
    b. Non-corrosive
    c. Less friction
    d. Connects with fittings by using solvent welding

6. Disadvantages of PVC
    a. Cannot use hot water
    b. If a mistake is made in fitting, then it must be removed by cutting PVC pipe

7. Comments

    a. Solvents will dissolve pipes and fittings
    b. PVC must be fused by solvent welding

II. Pipe Fittings

A. Coupling

1. Used to connect straight lengths of pipe
2. Connects pipe of the same size

B. Straight crosses

1. Branches the pipe off in opposite directions

C. Caps

1. Closes the end of the pipe

D. Elbow

1. Changes the direction of the pipe
2. Can reduce one end of the pipe

E. Bushing or reducer

1. To make pipe opening smaller depending on the flow
2. To make pipe opening larger depending on the flow

F. Straight tee

1. Used to branch off of main pipe line
2. May reduce the flow

G. Unions

1. Used to connect two pieces of pipe where neither one can be turned
2. Used where part of a system will have to be removed for repair or replacement

H. Plug

1. Used to close the end of a pipe when it ends with a fitting

I. Street elbow

1. Used to close turns

J. Nipple

1. Used to connect two fittings

a. Closed
b. Short
c. Long

K. Transition fittings

1. Used to join pipe of different material

L. Valves

1. Used to shut off or control the flow of liquid or air

a. Globe valve

1) Control the rate of flow
2) Vary the rate of flow

b. Gate valve

1) Open completely
2) Shut completely

M. Faucets

1. Device connected to the end of a pipeline to shut off or control the flow of the fluid
2. The flow is shut off by screwing a washer valve against a seat
3. Faucet washers are replaceable

III. Threading Compounds

A. Threading compound

1. Types of threading compound

a. White tape
b. Teflon tape
c. Pipe joint compound
d. Pipe dope
e. Mop stran

2. Why use thread compound

a. Insures tight joint
b. Prevents threads from rusting
c. Possibly prevent electrical ground

IV. Plumbing Tools

- A. Pipe wrench
  1. Size by length (6" - 60")
  2. Average size is 24"
  3. Used for connecting round fittings and pipe
- B. Pipe vise
  1. Holds pipe for cutting, threading and connecting purposes
  2. Best used for steel pipe
- C. Pipe cutter
  1. One to four cutters
  2. If more than one cutter, then there is not enough room to revolve the cutter
  3. To cut iron or copper piping: use a hacksaw
  4. To cut flexible or rigid copper: use pipe cutters
  5. To cut plastic: miter box or 8 tooth handsaw
- D. Reamer
  1. To remove burrs from piping
  2. Iron piping
     - a. Use reamer (large)
  3. Copper or plastic
     - a. Pocket knife
     - b. Half round file
     - c. Coarse sandpaper
  4. Flexible copper
     - a. Emery cloth
- E. Tap and die
  1. Dies
     - a. Used to cut threads or ends of steel pipe
  2. Taps
     - a. Used to cut threads inside holes

F. Hacksaw

1. Used for cutting iron or copper pipe

G. Taper triangular file

1. For removing burrs from the outside of iron pipe

V. Cutting Oil

A. Helps to cut smoother
B. Helps to cut easier
C. It will last longer
D. Helps to remove burrs from dies

VI. Common Size of Pipe Used in Plumbing

A. 1/4"
B. 1/2"
C. 3/4"
D. 1"
E. 1 1/4"

VII. Difference Between Bolt and Pipe Threads

A. Pipe threads

1. Tapered 1/16" per inch
2. Pipe has standard threads

B. Bolt threads

1. Straight threads

a. National coarse
b. National fine

VIII. Cutting, Reaming, Threading

A. Cutting

1. Measure length of pipe desired
2. Mark desired length with tapered triangular file
3. Fasten pipe in vise so mark is at least 4" from vise
4. Place pipe cutter on mark
5. Tighten pipe cutter by screwing in handle until cutting wheel is snug against pipe
6. Hold handle perpendicular to the pipe and tighten handle until cutting wheel penetrates the metal
7. Turn pipe cutter 1/4 turn per revolution until pipe is cut off
8. Check out for squareness

B. Reaming

1. Fasten pipe in vise allowing 4" to extend from vise
2. Place reamer in line with pipe
3. Turn reamer clockwise until inside burr is off
4. Remove reamer and check with finger to see if burr is cut away. *Do not cut more than necessary as first threads on pipe will be weakened

C. Threading

1. Place pipe in vise and allow 6" to extend from vise
2. File off any outside burr that may be on pipe end caused by cutting pipe
3. Place proper size die in stock
4. Place pressure against die holder with palm of hand, turn clockwise until die starts cutting threads
5. Use cutting oil on the threading area at all times
6. Continue threading until one thread is past the die
7. Back off die and inspect threads
8. Use wire brush and clean threads

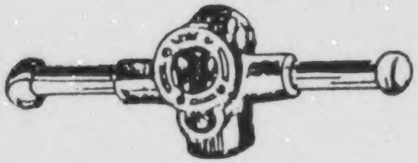
D. Connecting

1. Cut desired length of PVC pipe using a miter box and an 8 point handsaw
2. Remove burrs with a pocket knife
3. Clean the PVC pipe with a rag
4. Make a dry fit check

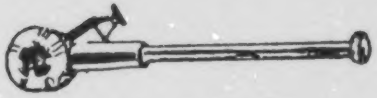
    a. The fitting must enter 1/3 of the way without force
    b. Use sandpaper or a file to remove any grooves

5. Remove glass color - primer of sandpaper
6. Apply cement - thin coating
7. Work quickly and assemble immediately
8. Rotate and hold 1 minute
9. Wipe off excess cement
10. Don't disturb for 30 minutes to 4 hours
11. Keep temperature less than 60°F

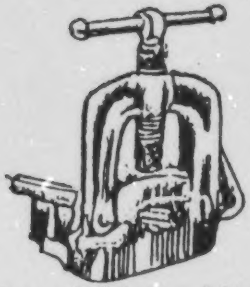
Plumbing Tools



3-Way Pipe Threaders

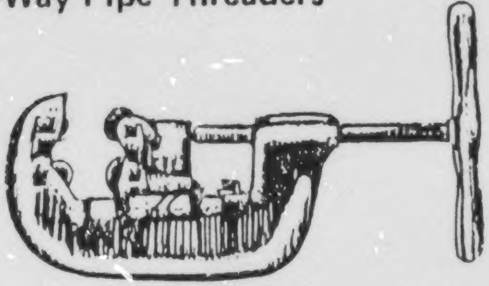


Small Ratchet Threaders

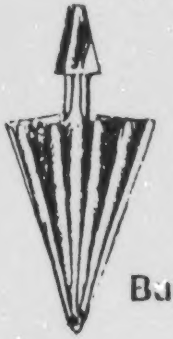


Bench Yoke Vises

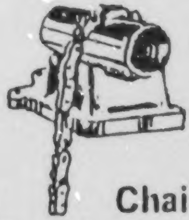
Appendix A



Pipe Cutter

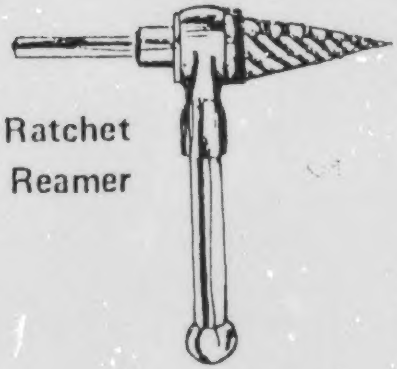


Burr Reamer

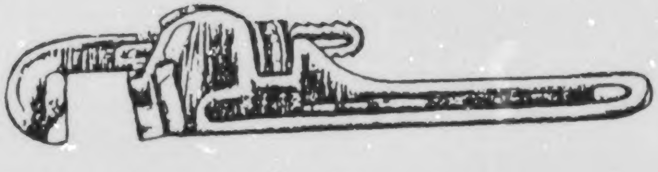


Chain Vises

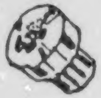
AgIII-V-13



Spiral Ratchet
Pipe Reamer

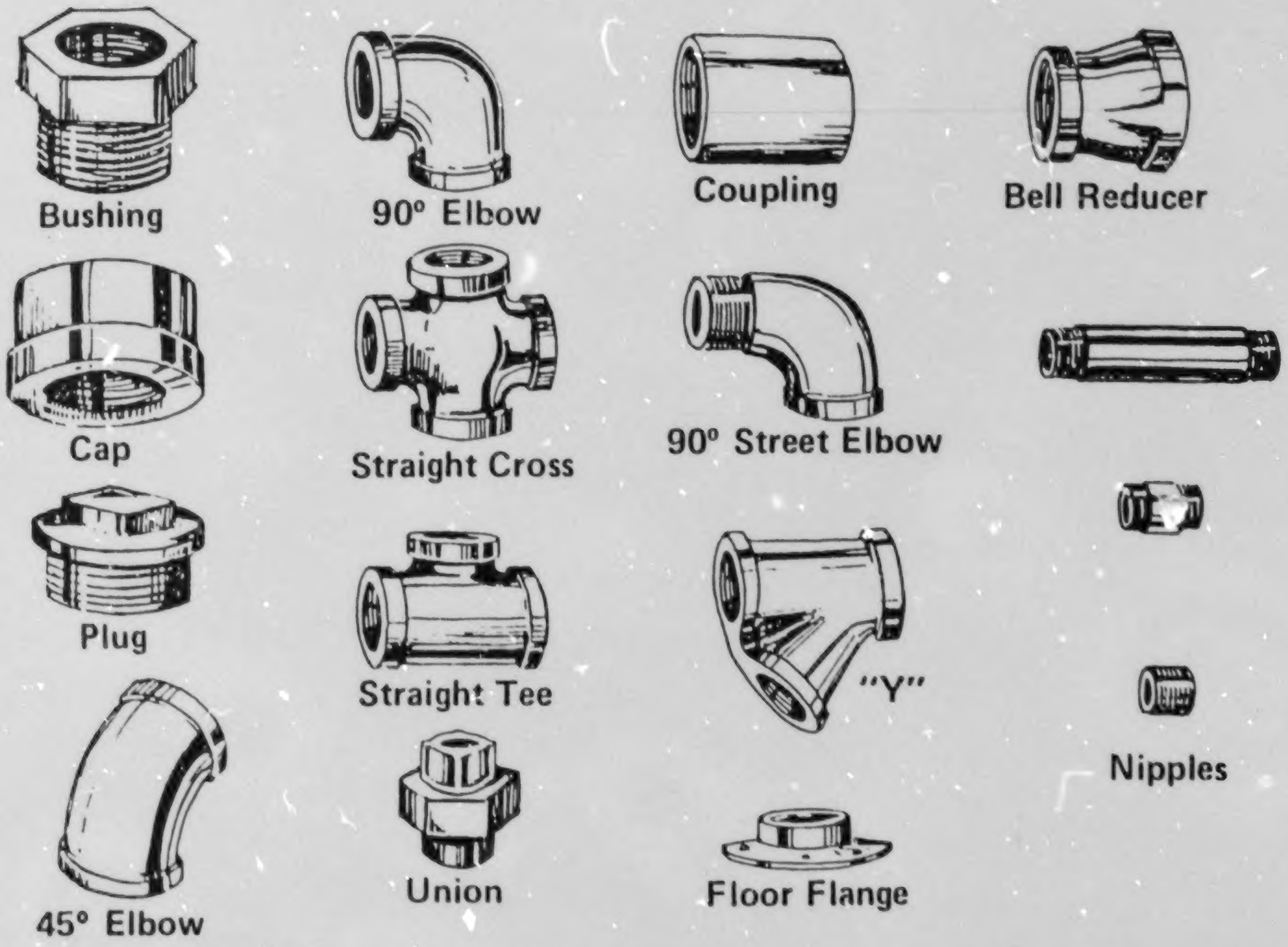


Pipe Wrench



Die

Pipe Fittings


Bushing
90° Elbow
Coupling
Bell Reducer
Cap
Straight Cross
90° Street Elbow
Plug
Straight Tee
"Y"
Nipples
45° Elbow
Union
Floor Flange

Appendix C

8. INSTALLING SWEAT-TYPE FITTINGS

Sweat-type fittings are a means of making joints and connections in copper tubing. They are widely used in home plumbing as well as in refrigeration and other industrial applications. They should not be used for connections on gas lines because in the event of fire the solder will melt and release the gas.

Types of tubing

Generally there are two types of copper tubing used -- hard drawn and soft drawn.

Soft drawn copper tubing is used on small applications. It is easy to work with and can be bent into any desired shape. Even though this tubing is easily shaped it has a tensile strength of 30,000 psi. Soft drawn copper tubing is supplied in rolls or coils.

Hard drawn copper tubing is normally used on large units where long lengths of tubing are required. It is difficult to bend and usually comes in 20 ft. lengths. It is similar to pipe in appearance. Hard drawn copper tubing has a tensile strength of 48,000 psi. which makes it stronger than soft drawn copper tubing.

Both types of copper tubing are seamless. Copper tubing is available in sizes from 1/8 inch up to several inches in diameter. Sweat-type fittings are a quick and inexpensive means of making a joint. An inexperienced workman can do high quality work with very little training or practice if care is taken with each of the steps listed below. Since the melted copper is drawn into the solder fitting by capillary action, much as ink is drawn into a blotter, the space tolerance between the tube and fitting must be carefully controlled. This means that both types of tubing must be handled carefully to prevent the ends of the tubing from being dented or distorted.

Steps in installing sweat fittings

1. Cut the tubing--Cut the copper tubing to the length required with a tubing cutter or a hack saw (32 teeth per inch). When sawing large diameter tubing, a template of thin straight edged sheet metal or paper may be used to mark a line to guide the saw cut. The ends of the tubing must be cut square.

2. Ream the tubing--Use a reamer or a round or half-round file to remove outside and inside burrs. Correct any distortion of the tube end. Improper joint clearance can lead to problems often caused by flux entrapment and inadequate bonding. Where insufficient clearances are used, such as fittings hammered into position, the capillary action in the joint is restricted and defects occur. When excessive clearances are used, there is some loss in mechanical strength and joints are apt to fail. Rounding or chamfering the edges of large diameter tubing will make it easier to insert the tube into the sleeve of the fitting.

3. Clean the tube and fitting--Clean the outside surface of the tube and the inside of the fitting until the metal is bright. All traces of discoloration must be removed. This must be done even though the tube and fitting appear to be perfectly clean. This is particularly important when soldering joints in large pipe. Some workmen rely on the corrosive action of the flux to clean the tubing but this is not recommended.

Emery paper is the most satisfactory material for cleaning. Special brushes are available to clean the outside of the tubing and the inside of the fitting. Fine steel wool (No. 00) may be used but oil in steel wool may make a poor joint. Files, rough sandpaper, and scrapers score the surface of the metal and help create a poor joint. After the tube and fitting are cleaned with emery cloth, apply the flux at once. Do not touch the cleaned surfaces prior to fluxing. Even a fingerprint may result in a defective joint.

4. Flux the tube and fitting--Apply a thin, uniform, and complete coating of flux or paste to a cleaned portion of the tube and fitting. Do not apply the flux too thickly as excess flux may form bubbles and prevent the solder from flowing into the joint. After the tubing has been inserted into the fitting

as far as it will go, revolve the fitting or the tube once or twice to spread the flux evenly.

5. Heat the joint and apply solder--As the joint heats, move the flame back from the edge of the joint and apply the wire solder at this point. At the right temperature a drop of solder will melt from the wire. Continue to apply the solder which will be drawn into the joint until it is filled. Extreme care should be used to prevent overheating the joint which may cause the flux to burn. If so the solder will not enter the joint, and it will be necessary to reclean the surface.

The above procedure applies particularly to soldering fittings up to 2 inches in size. When soldering larger fittings, it is more difficult to heat them evenly because of the greater mass to be heated. There is a difference of opinion about whether one or more heating units should be used to make larger joints. Care must be taken to prevent spot overheating when more than one heating unit is used.

When one heating unit is used, the following procedure is suggested:

Move the flame uniformly over the entire area of the joint including the tube area adjacent to the fitting until the entire joint is heated almost to the temperature required to melt the solder. Next, apply the flame over a limited area, a 2 or 3 in. arc of the circumference of the fitting, testing with the end of the wire solder until the solder flows into the joint. The heated section should be thoroughly filled with solder. Similar sections should be heated and the same procedure followed, overlapping the completed section, until the entire joint has been filled.

An oxyacetylene torch with a medium-sized tip will be found more efficient for joints of 4 in. diameter or larger because the heat is lost rapidly from such a large area. For the smaller diameters, a propane or butane torch, an air-acetylene torch, or a gasoline blow-torch may be used.

Some workmen use a soldering compound that is a combination solder and flux. It is relatively expensive but it eliminates one operation. If this does not provide sufficient solder in the joint, wire solder can be used to supplement it.

To avoid applying too much solder to the joint, some workmen bend a kink in the wire solder, a distance from the end equal to the diameter of the tube. If 1/8 in. wire solder is used, it will require about 1/2 in. of solder to complete a 1/2 in. soldered connection.

6. Allow the joint to cool--Do not move the soldered joint until it is fully hardened. This is very critical as many joints are ruined by disturbing them before the solder has completely solidified.

7. Remove surplus solder and flux with a damp cloth or brush.

If the fitting to be soldered is a Tee, it may be necessary to place a wet cloth over the parts already soldered to prevent that solder from melting. If the soldering is to be done on a closed system, some opening must be provided to permit expansion of gases. If water is trapped, the heat will generate steam and it will escape through the recently soldered joint causing it to leak. When sweating male and female adaptors, more time must be allowed for the solder to set as heavier fittings hold heat longer and do not cool as quickly as plain-type fittings.

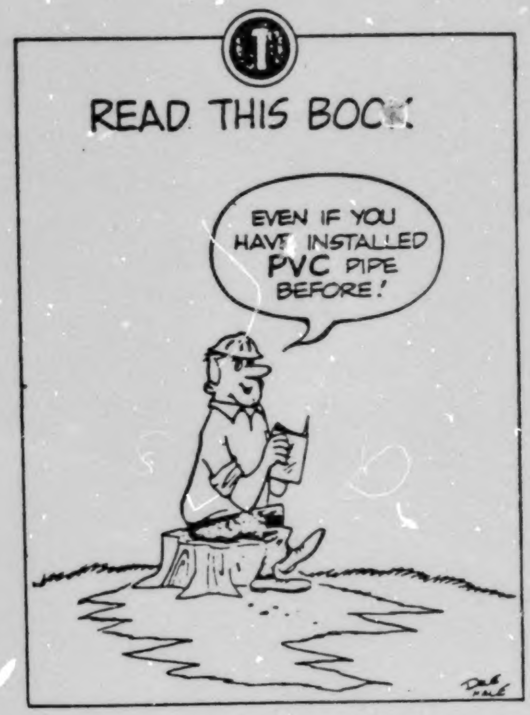
Use asbestos board (transite) or sheet asbestos to protect walls, joists, and studding when sweating fittings. Be sure the pipes are free of water and steam and the section [illegible] pipe is vented or steam pressure inside t[illegible] pipe will prevent the joint from sealing.

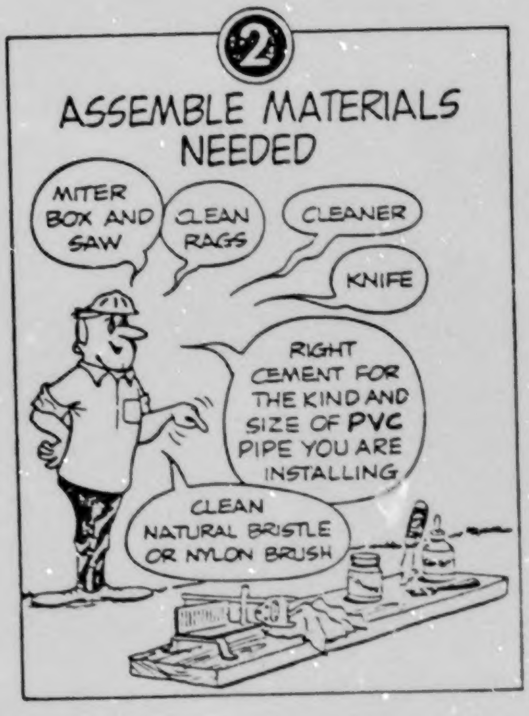
Appendix D

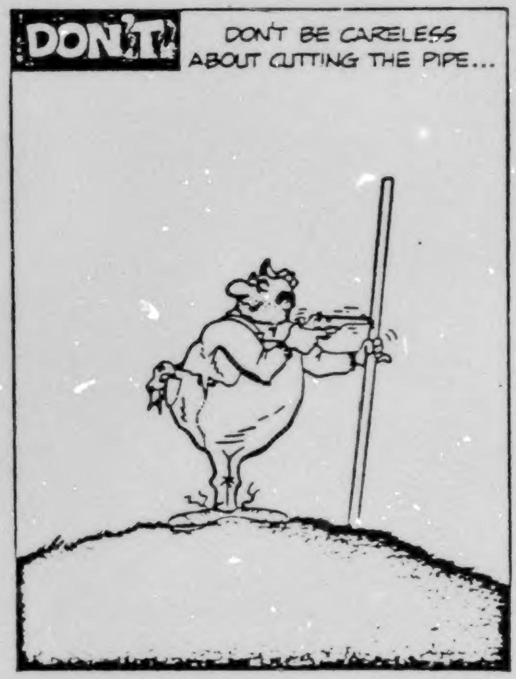
PLASTICS PIPE INSTITUTE

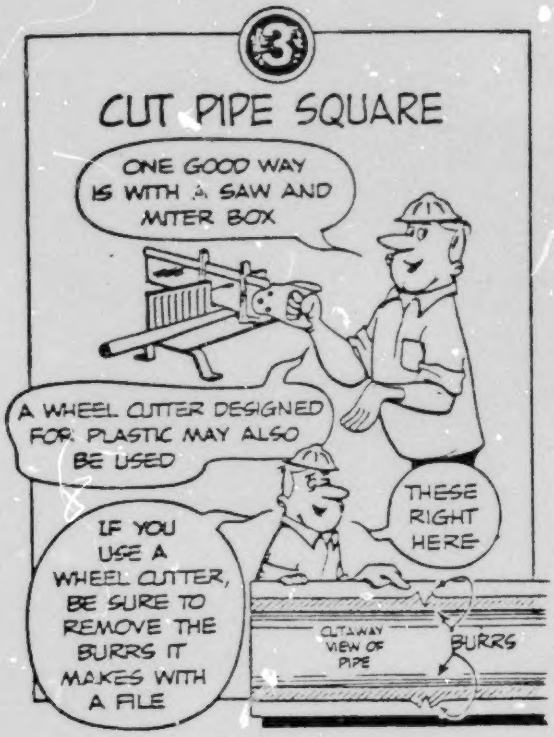
Presents....

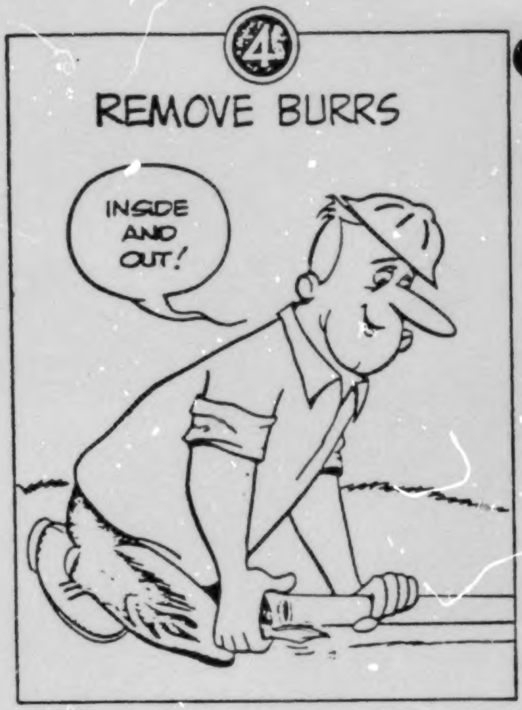
"CEMENTING of PVC PRESSURE PIPE"

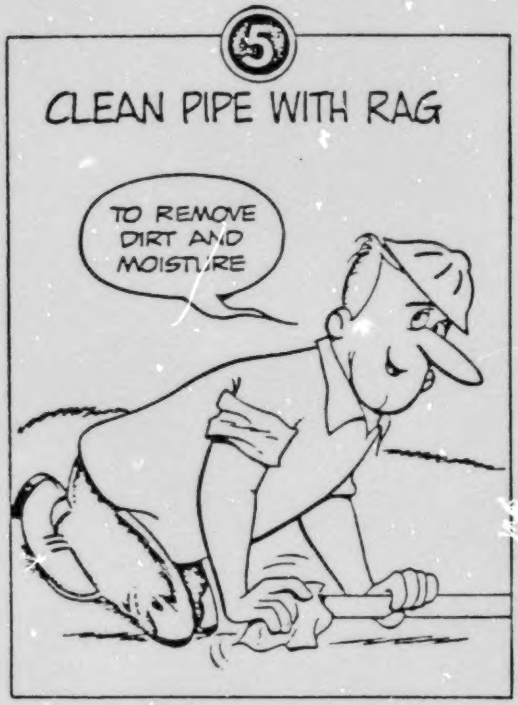

1
READ THIS BOOK
EVEN IF YOU HAVE INSTALLED PVC PIPE BEFORE!

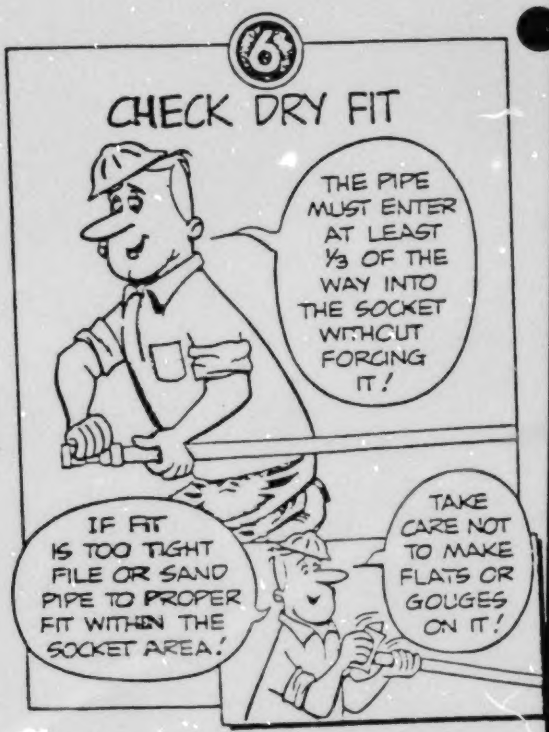

2
ASSEMBLE MATERIALS NEEDED
MITER BOX AND SAW
CLEAN RAGS
CLEANER
KNIFE
RIGHT CEMENT FOR THE KIND AND SIZE OF PVC PIPE YOU ARE INSTALLING
CLEAN NATURAL BRISTLE OR NYLON BRUSH

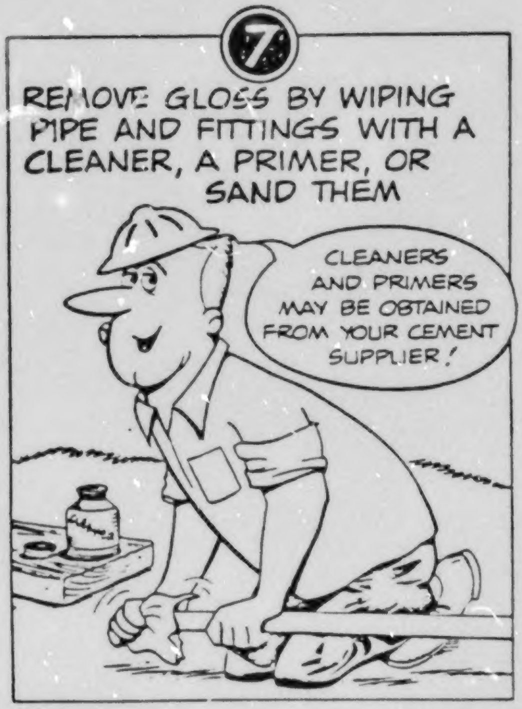

DON'T!
DON'T BE CARELESS ABOUT CUTTING THE PIPE...

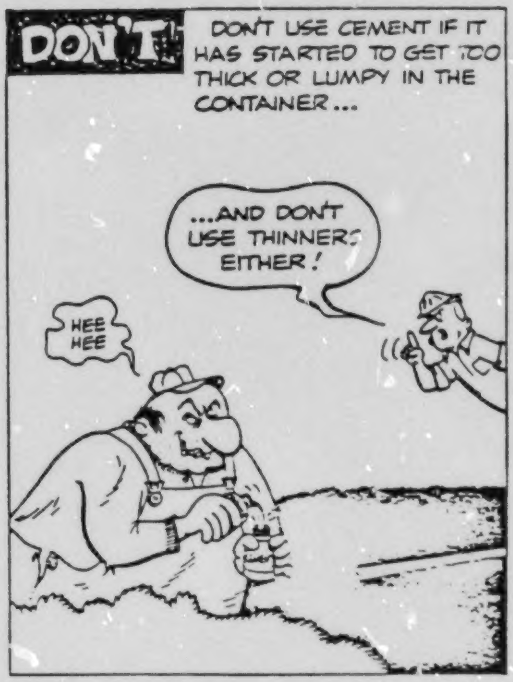

3
CUT PIPE SQUARE
ONE GOOD WAY IS WITH A SAW AND MITER BOX
A WHEEL CUTTER DESIGNED FOR PLASTIC MAY ALSO BE USED
THESE RIGHT HERE
IF YOU USE A WHEEL CUTTER, BE SURE TO REMOVE THE BURRS IT MAKES WITH A FILE
CUTAWAY VIEW OF PIPE
BURRS

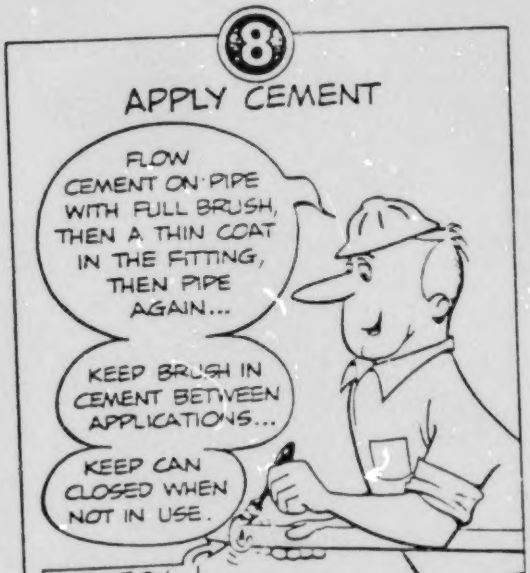

4
REMOVE BURRS
INSIDE AND OUT!

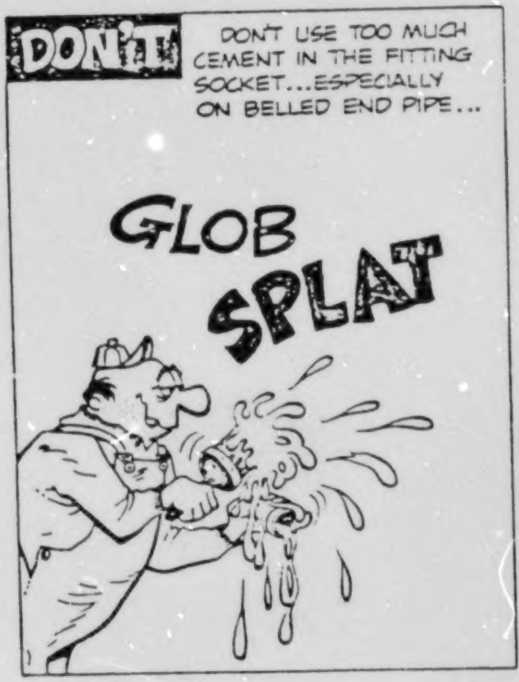

5
CLEAN PIPE WITH RAG
TO REMOVE DIRT AND MOISTURE

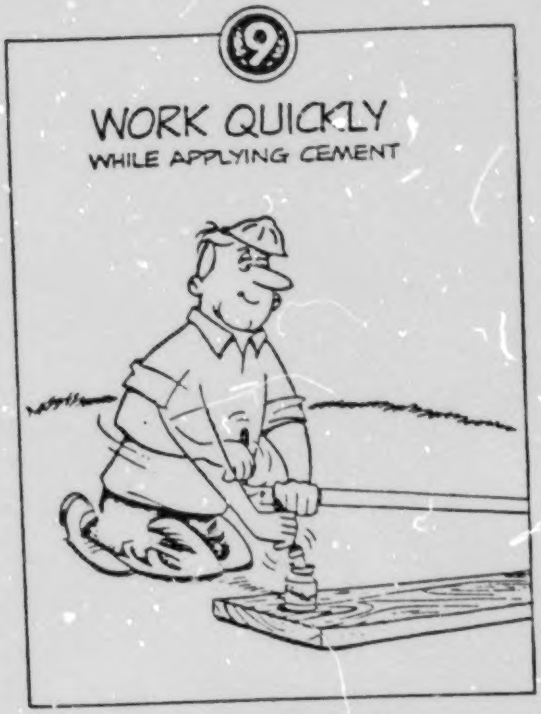

6
CHECK DRY FIT
THE PIPE MUST ENTER AT LEAST 1/3 OF THE WAY INTO THE SOCKET WITHOUT FORCING IT!
IF FIT IS TOO TIGHT FILE OR SAND PIPE TO PROPER FIT WITHIN THE SOCKET AREA!
TAKE CARE NOT TO MAKE FLATS OR GOUGES ON IT!

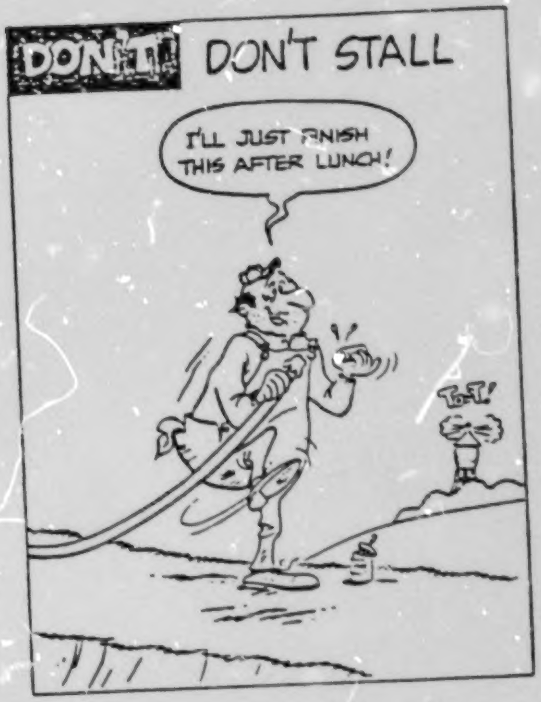

7
REMOVE GLOSS BY WIPING PIPE AND FITTINGS WITH A CLEANER, A PRIMER, OR SAND THEM
CLEANERS AND PRIMERS MAY BE OBTAINED FROM YOUR CEMENT SUPPLIER!

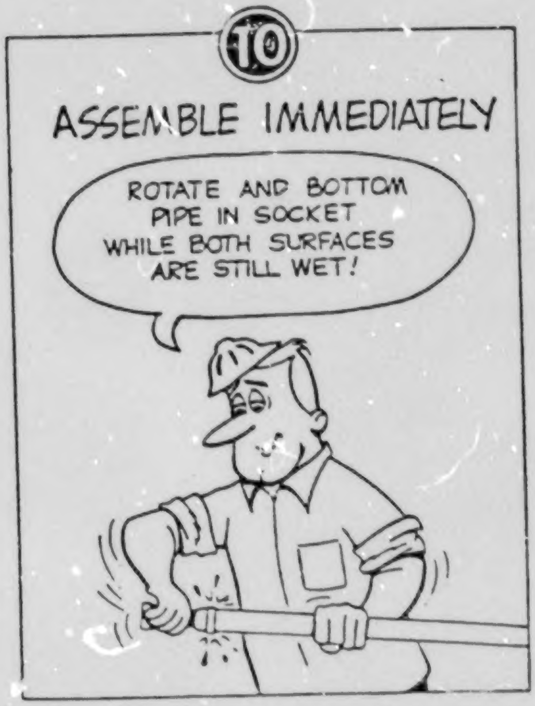

DON'T!
DON'T USE CEMENT IF IT HAS STARTED TO GET TOO THICK OR LUMPY IN THE CONTAINER...
...AND DON'T USE THINNERS EITHER!
HEE HEE

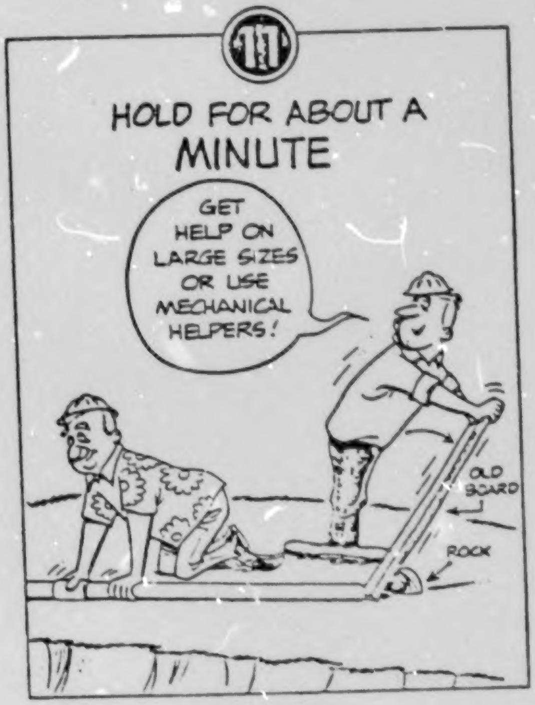

8
APPLY CEMENT
FLOW CEMENT ON PIPE WITH FULL BRUSH, THEN A THIN COAT IN THE FITTING, THEN PIPE AGAIN...
KEEP BRUSH IN CEMENT BETWEEN APPLICATIONS...
KEEP CAN CLOSED WHEN NOT IN USE.
FLOW IT ON
USE A BRUSH ABOUT ½ THE SIZE OF THE PIPE
CEMENT

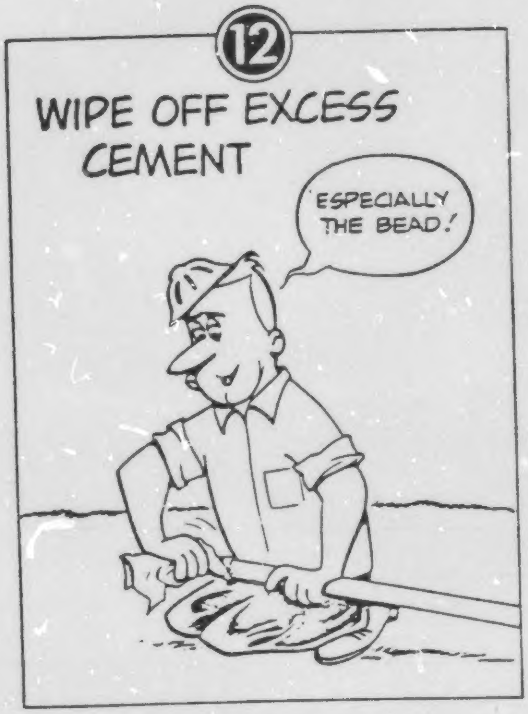

DON'T!
DON'T USE TOO MUCH CEMENT IN THE FITTING SOCKET...ESPECIALLY ON BELLED END PIPE...
GLOB
SPLAT

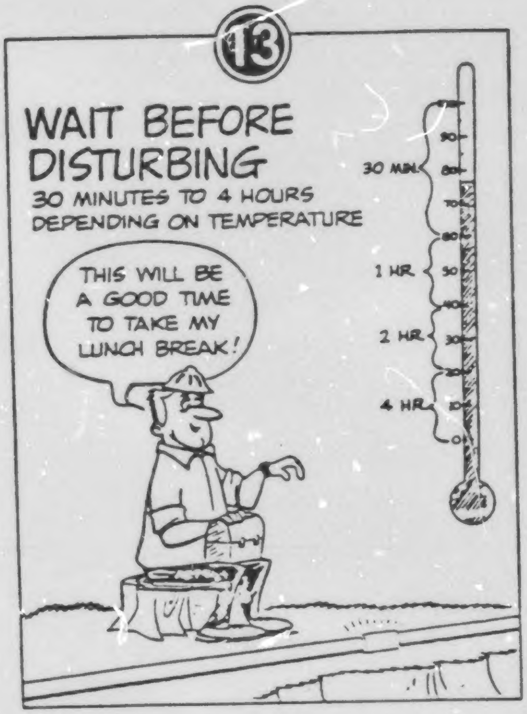

9
WORK QUICKLY
WHILE APPLYING CEMENT

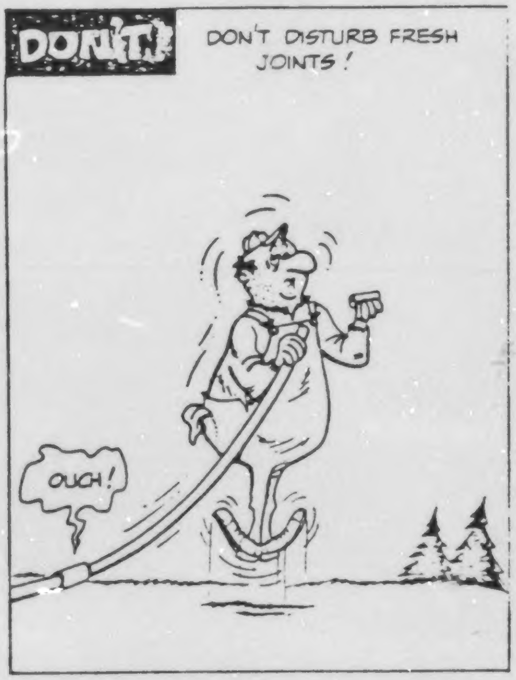

DON'T!
DON'T STALL
I'LL JUST FINISH THIS AFTER LUNCH!
TS-T!

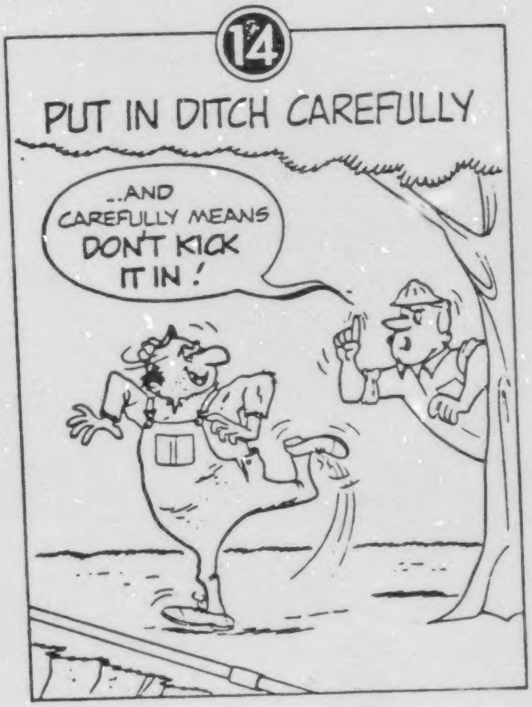

10
ASSEMBLE IMMEDIATELY
ROTATE AND BOTTOM PIPE IN SOCKET WHILE BOTH SURFACES ARE STILL WET!

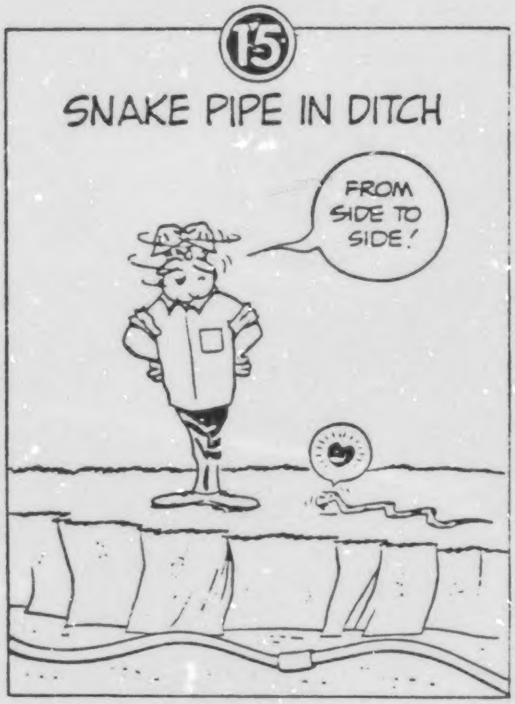

11
HOLD FOR ABOUT A MINUTE
GET HELP ON LARGE SIZES OR USE MECHANICAL HELPERS!
OLD BOARD
ROCK

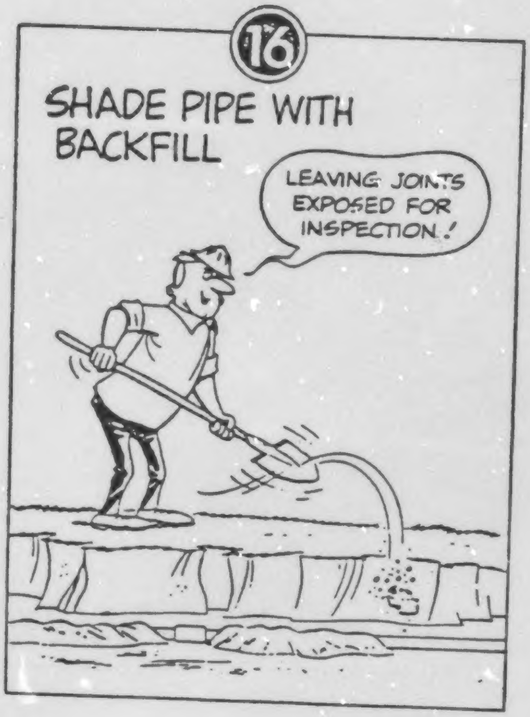

12
WIPE OFF EXCESS CEMENT
ESPECIALLY THE BEAD!

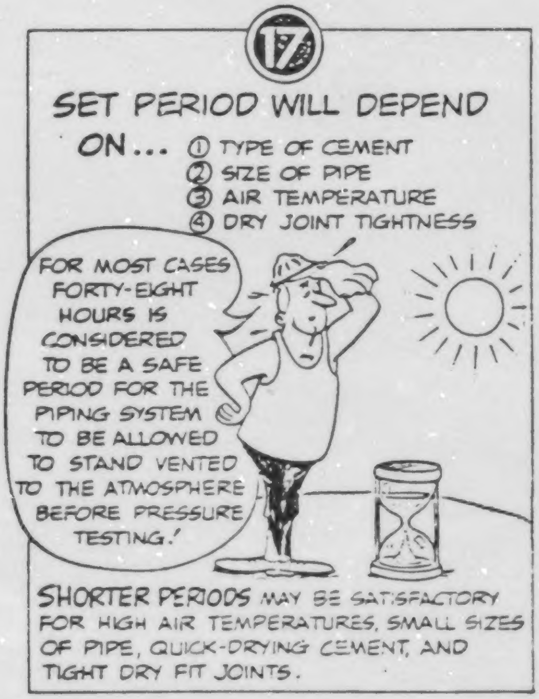

13
WAIT BEFORE DISTURBING
30 MINUTES TO 4 HOURS DEPENDING ON TEMPERATURE
THIS WILL BE A GOOD TIME TO TAKE MY LUNCH BREAK!
30 MIN.
1 HR.
2 HR.
4 HR.

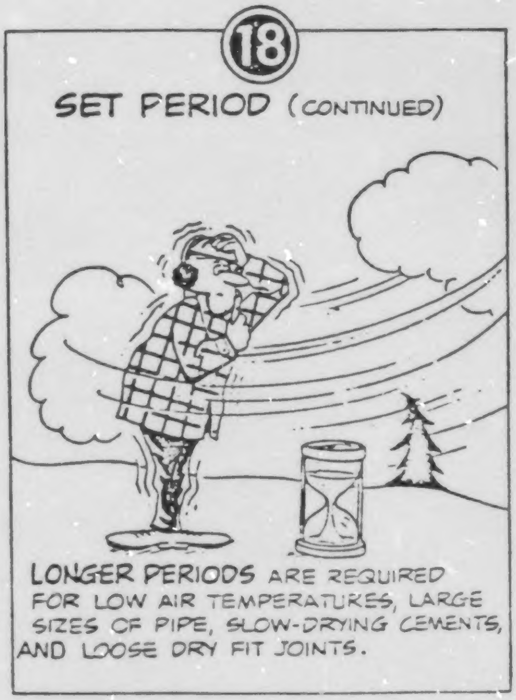

DON'T!
DON'T DISTURB FRESH JOINTS!
OUCH!

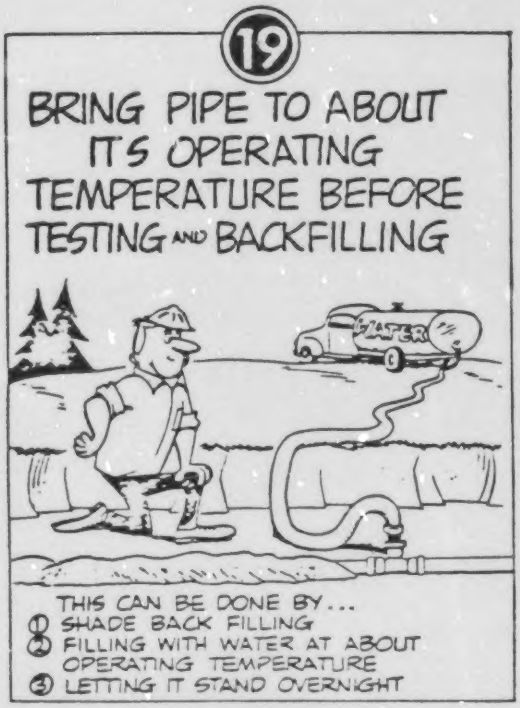

14
PUT IN DITCH CAREFULLY
..AND CAREFULLY MEANS DON'T KICK IT IN!

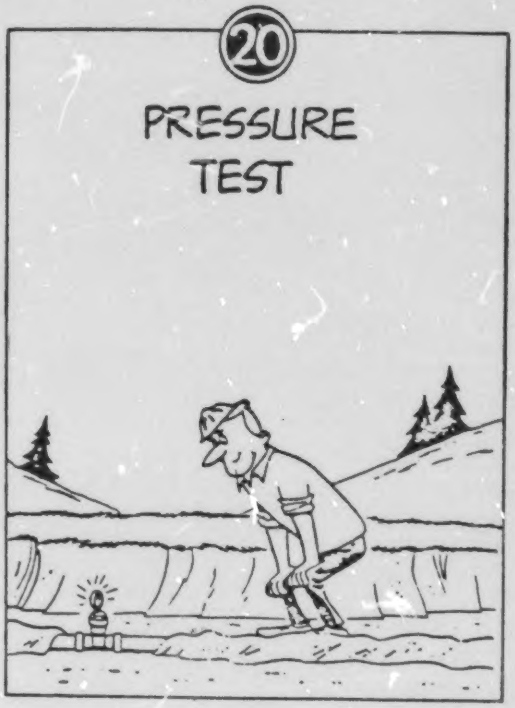

15
SNAKE PIPE IN DITCH
FROM SIDE TO SIDE!


16
SHADE PIPE WITH BACKFILL
LEAVING JOINTS EXPOSED FOR INSPECTION!


17
SET PERIOD WILL DEPEND ON...
① TYPE OF CEMENT
② SIZE OF PIPE
③ AIR TEMPERATURE
④ DRY JOINT TIGHTNESS
FOR MOST CASES FORTY-EIGHT HOURS IS CONSIDERED TO BE A SAFE PERIOD FOR THE PIPING SYSTEM TO BE ALLOWED TO STAND VENTED TO THE ATMOSPHERE BEFORE PRESSURE TESTING!
SHORTER PERIODS MAY BE SATISFACTORY FOR HIGH AIR TEMPERATURES, SMALL SIZES OF PIPE, QUICK-DRYING CEMENT, AND TIGHT DRY FIT JOINTS.


18
SET PERIOD (CONTINUED)
LONGER PERIODS ARE REQUIRED FOR LOW AIR TEMPERATURES, LARGE SIZES OF PIPE, SLOW-DRYING CEMENTS, AND LOOSE DRY FIT JOINTS.


19
BRING PIPE TO ABOUT IT'S OPERATING TEMPERATURE BEFORE TESTING AND BACKFILLING
WATER
THIS CAN BE DONE BY...
① SHADE BACK FILLING
② FILLING WITH WATER AT ABOUT OPERATING TEMPERATURE
③ LETTING IT STAND OVERNIGHT


20
PRESSURE TEST

CONGRATULATIONS
...IF YOU'VE FOLLOWED INSTRUCTIONS CORRECTLY, YOU OWE YOURSELF A PAT ON THE BACK FOR A JOB WELL DONE...
PAT! PAT!

WE TAKE IT SERIOUSLY!

Industrial Polychemical Service has been deeply involved for more than a decade in making quality tested solvent cements for plastic pipe.

Because of this experience we were happy to have a part in the presentation of this entertaining booklet.

We felt, with other PPI members, that a serious subject need not be somber and that responsible persons will recognize the serious intent behind the presentation. It is in this spirit that we pla,ed our part.

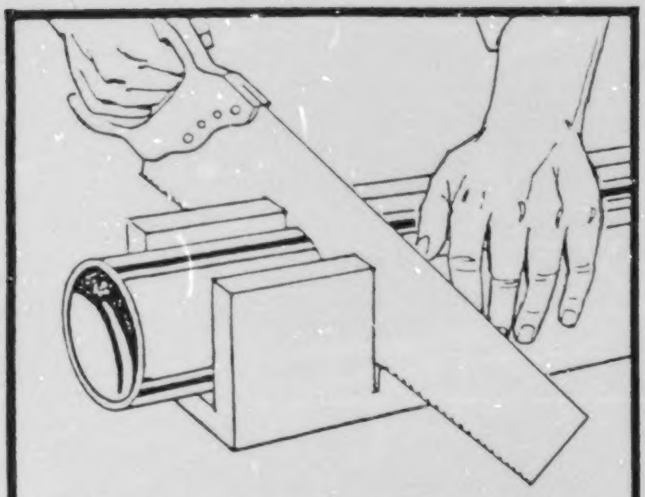
But the successful joining of plastic pipe requires the best of technology, art and old fashioned common sense — and ***WE TAKE IT SERIOUSLY!***

IPS INDUSTRIAL POLYCHEMICAL SERVICE
[illegible] S. BROADWAY, GARDENA, CALIFORNIA [illegible], AREA [illegible]

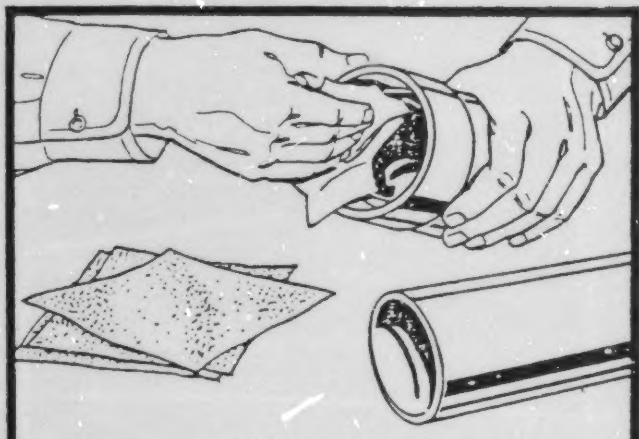
MANUFACTURERS OF WELD-ON CEMENTS

WORKING WITH SEARS ABS PIPE

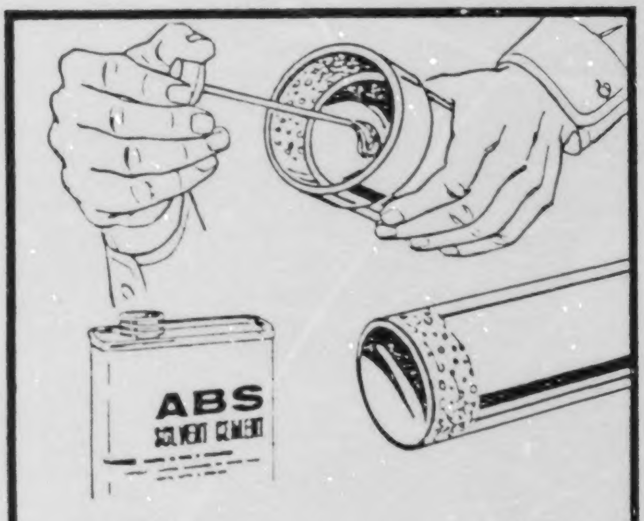
The four simple steps for installing Sears ABS pipe are illustrated below. All you need is a measuring tape, fine tooth saw (to cut the pipe), emery paper (to clean and smooth cuts), a can of ABS solvent cement (brush is in the cap) and a supply of clean rags.



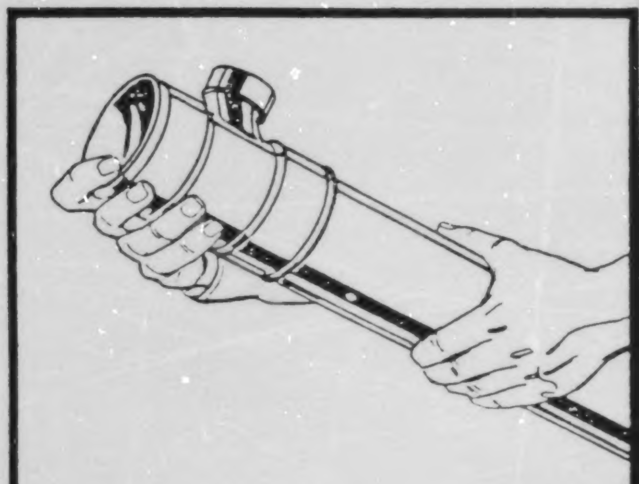
Step 1 Cut pipe to length desired. A mitre box and crosscut saw will assure square ends for correct sealing in socket type fittings.



Step 2 With cloth, wipe dirt, oil, or water from fitting socket.

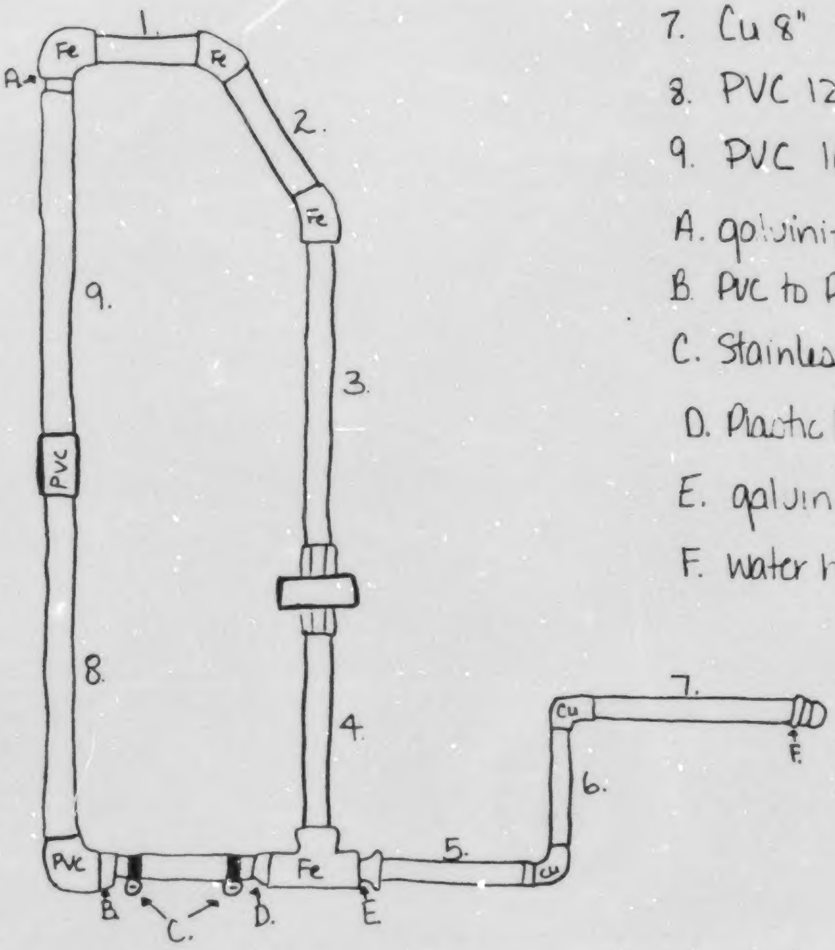


Step 3 Clean pipe end of burrs, dirt, etc. Apply ABS Solvent to pipe end. Brush on ABS Solvent in inside of fitting socket.



Step 4 Join fitting and pipe. Sets in two minutes for a permanent leak proof joint.

Plumbing Exercise


1.
Fe
Fe
A.
2.
Fe
9.
3.
PVC
8.
4.
7.
Cu
F.
6.
5.
PVC
Fe
Cu
B.
C.
D.
E.

Specifications

1. Fe 4"
2. Fe 6 3/8"
3. Fe 11 1/4"
4. Fe 8"
5. Cu 6"
6. Cu 4"
7. Cu 8"
8. PVC 12"
9. PVC 10 1/2"

A. galvinized Fe to PVC
B. PVC to Plastic Pipe
C. Stainless Steel pipe clamps
D. Plastic Pipe to galvinized
E. galvinized to copper
F. water hose attachment

Informative Speaking

Instructor's Guide

1. Informative speaking may be incorporated with other units throughout the school year.

2. The informative speaking unit may be conducted so it corresponds with the state contests.

3. Speeches may be prepared and/or extemporaneous.

Objectives:

Upon completion of this unit, the student will be able to:

1. Understand the requirements of an informative speech.

2. Prepare a manuscript for an informative speech.

3. Present informative speeches as a prepared speech and/or an extemporaneous speech.

Instructor's Activities:

1. Help students locate information for preparation of informative speeches.

2. State Public Speaking Contest information for Prepared and Extemporaneous is presented at the back of this unit. For updated information contact: State Department of Education
   State Department of Education
   700 Pringle Parkway SE
   Salem, Oregon 97310

3. Conduct informative speaking presentations using scoring sheets to help score and grade consistantly.

4. Help students to improve any areas of public speaking.

Student Activities:

1. Prepare informative speeches.

2. Present informative speeches as a prepared and/or as an extemporaneous.

Resources:

1. State Contest information.

Appendices:

1. Appendix A: Public Speaking Contests
2. Appendix B: Extemporaneous Public Speaking Contests

I. Informative Speaking

A. Why give a speech?

1. Speeches have a purpose

a. To entertain a group
b. To inform people
c. To stimulate people
d. To convince groups or individuals
e. To cause people to take action

2. Benefits of Public Speaking

a. Builds friendship
b. Exchanges information
c. Gives or asks orders
d. Entertains others
e. Displays wit, intelligence or information

B. Guidelines for Prepared and Extemporaneous Public Speaking

1. Guidelines for Prepared Public Speaking

a. Each speech is to be the result of their own research and composition
b. Must be a prepared speech on an agricultural topic
c. Speech length a minimum of 6 minutes and a maximum of 8 minutes
d. Question period of 5 minutes at conclusion of speech
e. Speeches presented with no audio or visual materials

2. Guidelines for Extemporaneous Public Speaking

a. The subject matter areas include:

1) Production agriculture
2) Agri-business
3) Current events in production agriculture and agri-business

b. 30 minutes of preparation time will be allowed
c. Note cards may be used
d. Speaking time will be not less than 4 minutes and not more than 6 minutes

C. How to Gather Information and Organize Speeches

1. Selecting a topic

   a. Select an agriculture related topic of interest
   b. Narrow the topic to a specific area, idea or fact

2. Collect information

   a. Books
   b. Brochures and/or pamphlets
   c. Setting up interviews with various resource possibilities

3. Organizing your speech

   a. Arrange information on note cards as acquired
   b. Organize according to points that are to be covered in an outline form

4. Prepared Public Speaking Format

   a. History
   b. Effects
   c. Causes
   d. Possible solutions
   e. Best solutions
   f. Audience action
   g. Extend problem solution

5. Extemporaneous Public Speaking Format

   a. Give an example or experience
   b. State question word for word
   c. State three parts to analyze
   d. Explain and expand the three parts one by one
   e. Answer question
   f. Conclude

D. The Length of Speech

1. Rule of thumb

   a. A rule of thumb is about 120 words per minute of length
   b. This is about the limit a person can speak and yet have everyone understand

2. Length Guidelines

    a. Length in minutes x words per minute = total words needed

    b. 3 x 120 = 360
    4 x 120 = 480
    5 x 120 = 600
    6 x 120 = 720
    7 x 120 = 840
    8 x 120 = 960

E. Final Touches

1. Reread the rough draft

2. Check list to consider

    a. Is the topic narrow and specific?
    b. Is the title catchy enough to strike interest?
    c. Does the introduction state statistics, facts or a problem that cause people to want to hear more?
    d. Will the speech entertain, inform, stimulate, convince or cause people to take action, or any combinations of these purposes?
    e. Are all the statements related to the topic and each other?
    f. Do the introduction, body and summary blend smoothly together?
    g. Is the speech mostly in your own words?
    h. Do you offer solutions to problems and state what others can do to help?
    i. Do you have a good summary that briefly reviews all points covered?
    j. Will the speech last the required amount of time?
    k. Is the english proper?
    l. Rewrite and make changes as needed when using this checklist.

F. Practicing the Speech Delivery

1. Use hand gestures to strengthen points.

2. Put expression and feeling into your face.

3. Become familiar enough with the speech so it's not read word-for-word.

4. Practice the speech before relatives, friends and a mirror.

5. Practice using a tape recorder.

G. The Speech Delivery

1. Talk to the audience, not to the floor or notes.
2. Make eye contact with various people around the room.
3. Do not bring attention to errors in speech delivery.
4. Stand up straight, do not lean on podium.

What Should an Outline Look Like?

I. INTRODUCTION
   A. Relationship establisher
   B. Interest gainer

II. MAIN IDEA
   A. Revelation of central thought
   B. Reason for giving this talk

III. BODY
   A. First main point
      1. Subheading--Development of point
         a. Supporting idea
         b. Further support
      2. ______________
   B. Second main point
      1. ______________
         a. ____________
         b. ____________
      2.

IV. CONCLUSION
   A. Summary or restatement
   B. Final punch line

Appendix A

SECTION IV

LEADERSHIP CONTESTS

A. PUBLIC SPEAKING CONTEST

This contest is designed to develop leadership abilities by providing participation in agricultural public speaking activities and stimulating interest in leadership and citizenship. Preliminary contests are of a local, district, interdistrict (sectional), state and regional character and are held under the auspices of the FFA unit concerned. These preliminary events culminate in the national contest held at the time of the FFA National Convention.

ELIGIBILITY

1. This contest is open to students less than 21 years of age at the time of their participation in the state contest, who are regularly enrolled high school vocational agriculture students and who are active members of chartered FFA chapters in good standing with the state association and the national organization. A member representing a state association in a regional or national contest is ineligible to compete in future contests.

2. The sectional contest winner will be eligible to compete in the state contest. The state winner will represent the Oregon Association in the Western Regional Contest.

GENERAL RULES AND REGULATIONS

1. EACH CONTESTANT'S SPEECH IS TO BE THE RESULT OF THEIR OWN RESEARCH AND COMPOSITION. Training in both composition and delivery is limited to the facilities of the school from which the contestant comes, but facts and working data may be secured from any source.

2. Contestants who have won the right to compete in a district, sectional or state contest, must file with the proper advisor through their teacher of vocational agriculture prior (as required by district or section) to the district or sectional contest and post-marked fourteen days prior to the state contest, the following materials:

   a. four double-spaced typewritten copies of the speech on 8-1/2 X 11" paper.
   b. a signed statement of originality of research and composition on form provided. (State Contest).
   c. a good clear glossy finished black and white phototgraph 3 X 5". (state contest)

3. A bibliography must be included as part of the public speaker's manuscript, and direct quotes from any other source of information must be marked in quotes on the manuscript and be identified in the bibliography. This applies to all contests above the local level. Failure to comply will result in disqualification.

4. Disqualification may result after results are determined and forfeiture of all awards may result.

5. Deductions of ten points will be made from the total score for each day that manuscripts are late, past post-mark, in arriving to state advisor.

6. Participants must wear official FFA dress in state contest. Twenty points will be deducted from the total score for those who fail to meet this requirement.

7. Official judges shall disqualify a contestant if he speaks on a non-agricultural subject. Contestants may choose any current subject for their speeches which is of an agricultural character (nature) and which is of general interest to the public.

8. Each speech shall be a minimum of six minutes in length and a maximum of eight minutes. Each contestant will be allowed five minutes additional time in which he will be asked questions relating to his speech. Deductions of 20 points per minute, or major fraction thereof, will be made from the score of each judge for speeches under six minutes or over eight minutes in length. (To prevent being penalized, a contestant must speak over five minutes, 30 seconds, and under eight minutes, 30 seconds.) (Major fraction = 30 seconds or more)

9. Contestants shall draw for places on the program. The program chairman shall then introduce each contestant by name only, in order of drawing and announce his speech title if desired by contestant.

10. A timekeeper shall be designated who will record the time used by each contestant in delivering his speech, noting over or under time, if any, for which deductions will be made.

11. When the contestants have finished speaking, each judge will total his score on composition and delivery for each contestant. The timekeeper's record will be used in computing the final score for each contestant. Contestants should be ranked in numerical order on basis of final score to be determined by each judge, first without consultation with each other. The judges' ranking of each contestant should be added, and the winner will be that contestant whose total ranking is the lowest.

12. Speeches are to be presented without aid of audio or visual materials except podium and/or microphone.

STATE CONTEST

1. Scoring judges for the state contest shall consist of the four second place sectional contest advisors and one selected by the state advisor from teams competing in the sectional contest.

2. It shall be the responsibility of the district advisors to notify the state advisor 14 days prior to the State Convention of the second place individual and other individual placings in the sectional contest.

3. Three impartial persons shall be selected as questioners who read the manuscript, formulate questions, and question each participant. Two copies of the questioners instructions are to be included with each manuscript.

4. Each participant will be limited to five minutes for questions. The official timer will call time at the end of the five minute question period and speaker will stop immediately.

5. Scoring judges shall not have copies of the speech manuscript in their possession during the contest. If scoring judges wish to review manuscripts, this must be done prior to or following the contest.

SECTIONAL AND DISTRICT CONTESTS

Sectional and district contests shall follow the format and/or regulations as established for the state contest. It shall be the responsibility of the district advisor, or local advisor in charge, to conduct the contest.

SCORING JUDGES INSTRUCTIONS

It is vital that the scoring judges conduct a brief orientation session prior to judging the contest, in order that they might judge the contest in a more consistent manner. The following items should be discussed and agreed upon prior to the contest:

1. The score sheet should be studied so all judges understand how it works.

2. Agree on how the score process should proceed. It is suggested that the first speaker be scored with leeway for both higher and lower scores. Succeeding speakers should then be scored on a comparative basis to the previous speaker(s).

3. Review score sheet terms and explanation of score sheet points. Copies of the national "Explanation of Score Sheet Points" should be attached to all score sheets.

4. The judges' numerical placings (1st, 2nd, 3rd, etc.), will be added to reach the final placing. See Rule 10 of General Rules and Regulations for details.

5. Agree on how to resolve tie placings.

6. Agree on where scoring judges will be seated. It is suggested that the judges spread out through the audience, so as not to influence one another and to better observe the speaker.

7. Designate one scoring judge to pick up the question forms (written comments) from all question judges. This must be done before retiring to tally scores.

8. Agree that if any scoring judges cannot hear the questions, that he will ask the questioners or the speaker to repeat the question.

9. Each judge will complete a critique form for each speech indicating both positive and negative comments.

AgIII-VI-11

STATE FFA PUBLIC SPEAKING CONTEST

Questioner's Instructions

Contestant's Name ______________________________

Speech Title: ______________________________

Judge's Name: ______________________________

Instructions

1. The persons selected as questioners are requested to prepare three brief questions for each speech. Questions shall pertain directly to the speakers' subject. Questions with two or more parts should be avoided.
2. Questions should be prepared prior to the contest and brought to the contest in complete and legible form.
3. Please phrase opinion questions (How do your feel about ---, what is your opinion of ---, etc.), carefully, as scoring judges must grade on the basis of logic, facts, and soundness of answers.
4. Each contestant is allowed five minutes for questions. The full five minutes should be used. The questioners (3) shall rotate in putting their questions.
5. Please present this form to the designated scoring judge at the conclusion of the contest. Your comments on the answers given would be appreciated.

QUESTION 1. ______________________________

____

____

QUESTIONER'S COMMENT: ______________________________

____

QUESTION 2. ______________________________

____

____

QUESTIONER'S COMMENT: ______________________________

____

QUESTION 3. ______________________________

____

____

QUESTIONER's COMMENT: ______________________________

____

STATE PUBLIC SPEAKING CONTEST

Future Farmers of America

Judges Score Sheet and Rules

Explanation of Score Sheet

Part I - For Scoring Contest and Composition (To be judged from oral presentation)

1. Content of the speech includes:
   - Importance and appropriateness of subject
   - Suitability of the material used
   - Accuracy of the statements included
   - Evidence of purpose
2. Composition of the speech includes:
   - Organization of the content
   - Unity of thought
   - Logical development
   - Language used
   - Accomplishment of purpose - conclusions

Part II - For Scoring Delivery of Production

1. Voice includes:
   - Quality
   - Pitch
   - Articulation
   - Pronunciation
   - Force
2. Stage presence includes:
   - Personal appearance
   - Poise and body posture
   - Gestures
   - Eye Contact
   - Attitude
   - Confidence
   - Personality
   - Ease before audience
3. Power of expression includes:
   - Fluency
   - Emphasis
   - Directness
   - Sincerity
   - Communicative ability
   - Conveyance of thought and meaning
4. Response to questions includes:
   *Ability to satisfactorily answer the questions on the speech which are asked by the judges indicating originality, familiarity with subject, and ability to think quickly.
5. General effect includes:
   Extent to which the speech was interesting, understandable, convincing, pleasing, and held attention.

*NOTE: Questioners should meet prior to the contest to prepare and clarify the questions to be asked.

JUDGES SCORE SHEET
STATE PUBLIC SPEAKING CONTEST--FUTURE FARMERS OF AMERICA

Part I. For Scoring Content and Composition:

Items to be scored	Points Allowed	Points awarded contestants 1	2	3	4	5	6	7	8	9	10
1. Content of the speech	200										
2. Composition of the speech	100										
Score on Content and Composition	300										

Part II. For Scoring Delivery of the Production:

Items to be scored	Points Allowed	Points awarded contestants 1	2	3	4	5	6	7	8	9	10
1. Voice	100										
2. Stage presence	100										
3. Power of expression	200										
4. Response to questions	200										
5. General effect	100										
Score on delivery	700										

Part III. For Computing the Results of the Contest:

Items to be scored	Points Allowed	Points awarded contestants 1	2	3	4	5	6	7	8	9	10
Totals of content, composition and delivery	1,000										
Less deductions for late manuscript	10 pts. day										
*Less overtime or undertime deductions, for each minute or major fraction thereof	20 pts.										
Less deduction for failure to wear official FFA dress	20 pts.										
GRAND TOTAL											
Numerical or Final placing of Contestants											

*From the timekeeper's record.

Appendix B

SECTION IV

B. EXTEMPORANEOUS PUBLIC SPEAKING CONTEST

The FFA Extemporaneous Public Speaking Contest is designed to develop leadership skills, motivation, and participation for all FFA members. The members will express themselves on a given subject without having prepared or rehearsed its content in advance. Preliminary contests are local, district, sectional, state, regional, with culmination in the national contest at the National FFA Convention.

ELIGIBILITY

1. This contest is open to students less than 21 years of age at the time of their participation in the state contest, who are regularly enrolled high school vocational agriculture students and who are active members of chartered FFA chapters in good standing with the state association and the national organization. A member representing a state association in subregional, regional, or national contests is ineligible to compete in future Extemporaneou Public Speaking contests.

2. The sectional contest winner will be eligible to compete in the state contest. The state winner will represent the Oregon Association in the Western Regional Contest.

3. A contestant is eligible at the sectional and state level to enter either the Extemporaneous Speaking or the Public Speaking contest, but not both.

GENERAL RULES AND REGULATIONS

1. Subject matter areas will be:

   --Production Agriculture
   --Related Agricultural Occupations (Agribusiness)
   --Current events in Production Agriculture and Agribusiness

2. Sub-topics in each of the three subject matter areas will be developed by impartial judges or advisors just prior to the contest.

3. Each subject matter area will have twice as many sub-topics as contestants.

4. The contestant will select one specific sub-topic in each of two (2) of the three (3) subject matter areas. From the two (2) selected sub-topics areas the contestant will decide on which topics will be presented with the remaining sub-topic area returned for possible use by a succeeding contestant. Sub-topics will be arranged and labeled by subject matter area. The sub-topics will be recorded and forwarded to the judges.

5. The selection of the topic will be held to allow 30 minutes of preparation prior to the contest. Since the speech can be from four to six minutes with three minutes of questions, the contestants should select their topic approximately 10-12 minutes apart.

6. A suitable quiet area free from distractions should be provided for contesta to prepare their speech.

7. Each speech shall be the result of the contestants own effort using any reference material which the contestant may bring to the preparation room. No other assistance may be provided. Any quotations must be acknowledged.

8. Uniform note cards will be provided each contestant. Any notes for speaking must be made during the 30 minute preparation period on note cards provided the contestants.

9. Each speech shall be not less than four or more than six minutes with three minutes additional time allowed for related questions which shall be asked by the question judges (not same as scoring judges).

10. Contestants are to be penalized one point per second on each judges score sheet for being over 6 minutes or under 4 minutes. Time commences when the speaker begins talking. Timer will indicate when it has been four (4) minutes.

11. The chairman of the contest shall introduce the contestants by name and chapter and the contestant may introduce the speech by title only.

12. Contestants must wear official FFA dress in the state contest.

13. The contestants shall draw for place on the order of speaking. Twenty points will be deducted from the total score for those who fail to meet this requirement.

14. Two time keepers shall be designated who will record the time used by each contestant in delivering the speech, noting overtime or undertime, if any. Time keepers shall be sitting together. Judges questions will be for 3 minutes from the time the first judge starts the questioning. Time keepers should call time at the end of 3 minutes at which time the questioning period will immediately cease.

15. When all contestants have finished speaking, each judge will total the score on each contestant. The timekeepers' record will be used in computing the final score for each contestant. The judges' score sheets will rank the contestants in numerical order on the basis of the final score without consultation with each other. The judges ranking of each contestant then should be added and the winner will be that contestant whose total ranking is the lowest. In case of a tie, that individual who has the highest grand total score shall have the prior ratings. Written critiques are recommended for contestants at the District and Sectional levels.

STATE CONTEST

1. Scoring judges for the state contest shall consist of the four second place sectional contest advisors and one advisor selected by the State Advisor. Also three question judges selected by the State Advisor.

2. Each questions judge shall formulate and ask questions. Questions shall pertain directly to the speaker's subject. Questions containing two or more parts should be avoided. Scoring judges will score each contestant on the ability to answer all questions asked by the question judges. The full three minutes for questions should be used.

3. At the time of the contest, the judges will be seated in different sections of the room in which the contest is held.

4. A written critique by the judges will be prepared for each state contestant and made available to them following the contest.

DISTRICT AND SECTIONAL CONTESTS

District and sectional contests shall follow the format and/or regulations as established for the state contest. It shall be the responsibility of the district advisor, or local advisor in charge, to conduct the contest.

JUDGES INSTRUCTIONS

It is vital that the scoring judges conduct a brief orientation session prior to judging the contest, in order that they might judge the contest in a more consistent manner. The following items should be discussed and agreed upon prior to the contest:

1. The score sheet should be studied so all judges understand how it works.
2. Agree on how the score process should proceed. It is suggested that the first speaker be scored with leeway for both higher and lower scores. Succeeding speakers should then be scored on a comparative basis to the previous speaker(s).
3. Review score sheet terms and explanation of score sheet points. Copies of the national "Explanation of Score Sheet Points" should be attached to all score sheets.
4. The judges' numerical placings (1st, 2nd, 3rd, etc.) will be added to reach the final placing. See Rule 15 of General Rules and Regulations for details.
5. Agree on how to resolve tie placings and making uniform deductions on official dress.
6. Agree on where scoring judges will be seated. It is suggested that the judges spread out through the audience, so as not to influence one another and to better observe the speaker.
7. The question judges will establish a rotation for putting the questions to each contestant prior to the contest.
8. Chairman judge will arrange a meeting with contestants prior to the contest.
9. Judge will supply written critique to each speaker.

STATE FFA EXTEMPORANEOUS SPEAKING CONTEST
JUDGES SCORE SHEET

	POINTS ALLOWED	NAMES OF CONTESTANTS								
		POINTS AWARDED CONTESTANTS								
KNOWLEDGE OF SUBJECT	200									
ORGANIZATION OF MATERIAL	100									
POWER OF EXPRESSION	200									
VOICE	100									
STAGE PRESENCE	100									
GENERAL EFFECT	100									
RESPONSE TO QUESTIONS	200									
TOTAL POINTS (gross)	1000									
LESS TIME DEDUCTIONS	(20 pts. dress) 1 pt./ second									
TOTAL POINTS (net)										
RANK OF CONTESTANT										

The final ranking sheet included with the rules shall be used to summarize judges'

STATE FFA EXTEMPORANEOUS SPEAKING CONTEST
EXPLANATION OF SCORE SHEET POINTS

1. KNOWLEDGE OF SUBJECT includes:
    - Importance and appropriateness of the subject
    - Suitablity of the material used
    - Accuracy of the statements included
    - Evidence of purpose

2. ORGANIZATION OF MATERIAL includes:
    - Organizations of the content
    - Unity of thought
    - Logical development
    - Language used
    - Sentence structure
    - Accomplishments of purpose - conclusions

3. VOICE includes:
    - Quality
    - Pitch
    - Articulation
    - Pronunciation
    - Force

4. STAGE PRESENCE includes:
    - Personal appearance
    - Poise and body posture
    - Attitude
    - Confidence
    - Personality
    - Ease before audience

5. POWER OF EXPRESSION includes:
    - Fluency
    - Emphasis
    - Directness
    - Sincerity
    - Communicative ability
    - Conveyance of thought and meaning

6. GENERAL EFFECT includes:
    - Extent to which the speech was interesting, understandable, convincing, pleasing, and held attention

7. RESPONSE TO QUESTIONS includes:
    - * Ability to answer the questions on the speech which are asked by the judges indicating originality, familiarity with subject, and ability to think quickly

*Judges should meet prior to the contest to prepare and clarify the questions to be asked.

RECORDS

Refer to AgI Guide Records Unit.

Applications

Introduction:

All people fill out applications of one kind or another sometime in their lives. This unit is provided for two reasons:

1. Give students experience at filling out applications.
2. The unit is timed so that this would be the correct timing for State Farmer and State Proficiency application completion by students.

If there are students in your class who do not want to fill out these types of applications secure agricultural loan application forms from the PCA or your local bank so all students may have the experience of correctly completing a detailed application form.

Objectives:

Upon completion of this unit, the student will be able to:

1. Understand the purpose of forms.
2. Complete detailed forms similar to those required in business.

Instructor Activities:

1. Motivate the students to complete forms. (Suggestions: (1) FFA-State Farmer Degree, State Proficiency Award, (2) Taking out loans for business, (3) Filling out forms for Federal, State and Local Governmental Agencies -- SWCS, Extension Service, Forest Service, Water Districts, etc.)
2. Secure appropriate forms for FFA from:

   State Department of Education
   700 Pringle Parkway SE
   Salem, Oregon 97310

3. Secure forms for business from local PCA, SCS office, Extension Service, Forest Service, Banks, etc.
4. Present general information on filling out forms.

Student Activities:

1. Participate in class discussion.
2. Complete appropriate forms.

Teaching Outline

Forms

I. Two sets of a form should be used by each person

   A. The first should be completed in pencil - this allows errors to be erased easily.

   B. The second form should not be touched until the first is completed correctly in pencil and checked for accuracy. Fill out the second form either typed or printing carefully and clearly in ink.

II. Supply that information which is required on the form used.

III. Location of Various Forms

   A. State Farmer Applications
      State Department of Education

   B. State Proficiency Applications
      FFA Activity Guide (also refer to Agricultural Proficiency Award References located in FFA Handbook)
      State Department of Education

   C. Miscellaneous Forms
      Extension Office
      SCS Office
      Forest Service
      Local Banks

Repair Welding Unit

Terminal Objective:

Upon completion of this unit the student will be able to identify special various metals used in agriculture and be able to repair them in the most appropriate fashion given economic and physical constraints of the individual situation.

Specific Objectives:

Upon completion of this unit the student will be able to:

1. Identify special metals used in agriculture (i.e. medium and high carbon steels, various forms of cast iron, aluminum brass, and stainless steel).
2. Appropriately repair broken metal sections of the following:
    a. Medium carbon steel
    b. High carbon steel
    c. Gray cast iron
    d. Aluminum
    e. Stainless steel
3. Hardsurface agricultural equipment parts subject to extensive wear.

Teaching Tips:

1. It is suggested that this unit be an optional unit - if local agriculture dictates that more effort and time go to harvesting machinery, preventive maintenance and plant science, this unit should be dropped or reduced.
2. Metal identification is a critical part of this unit; be as complete as possible in that section.
3. Proceed from metal identification to typical uses of various special metals in agriculture.
4. Repair various special metals as local area dictates need.

Metal Identification

Teaching Tips:

1. Develop a metal identification set for students to use after basic instruction.
2. Use a skill sheet similar to the one provided in this unit for the metal identification set.

FUNDAMENTALS FOR QUALITY WELDS

1. METAL IDENTIFICATION
2. ELECTRODE SELECTION
3. AMPERAGE
4. ARC LENGTH
5. SPEED OF TRAVEL
6. ANGLE OF ELECTRODE

Ferrous Metals-Properties, Identification and Treatment

HOW ARE METALS IDENTIFIED?

In this age metals have become complex and it is difficult to distinguish between them be a simple visual inspection. Often several methods of identification must be used when identifying a metal.

The chemical composition of a metal determines the properties of that metal. It is true that without the proper heat treatment, these properties cannot be developed. However, there is no heat treatment that will develop these properties if the metals are affected by chemical composition: weight, color, luster, corrosion resistance, strength, malleability, ductility, toughness, electrical conductivity, thermal-conductivity, magnetism, wear resistance, weldability, machinability, and formability.

Metals are classified into two main groups according to their chemical composition. Those having iron as the base element are called "ferrous" metals, and those having some other element are called "non-ferrous" metals.

It would be convenient to be able to send a metal to a metallurgical laboratory to be analyzed. However, this is not always possible and the responsibility is frequently left up to you to determine what the metal is, and based on this determination decide how to weld the metal. Some of the methods to identify metals include the following: color, weight, flame test, magnetic properties, chemical test, heat test, spark test, color codes, numbering systems, and electrical conductivity.

Color

Color is dependent upon the chemical composition of the metal. Copper, for example, has its own distinguishable color and so does brass. Color, however, cannot always be the sole criteria for identifying metal, because aluminum and magnesium have the same color and are obviously different metals.

Weight

If color does not help in the identification of a metal, weight can sometimes be used as the deciding factor. It must be remembered that weight per unit volume or density is important. In the case of aluminum and magnesium the identification can be successfully accomplished by weight only if the pieces of metal to be identified are approximately the same physical size.

Flame test

There are several metals that will burn readily. Examples of these are sodium, phosphorus, magnesium, and titanium. The most common use of the flame test is to distinguish aluminum from magnesium. Make some fine filings and heat with a flame, such as a propane torch. The magnesium filings will burn with a brilliant white glow while the aluminum filings will not burn but will simply melt away.

Magnetic properties

Magnetic attraction of a metal can be used in the identification of a metal but it can also fool you. A general rule is that ferrous metals are attracted by a magnet at room temperature. Some of the stainless steels are nonmagnetic at room temperature but will attract a magnet under certain heat treated conditions. Nickel, which is nonferrous, is magnetic at room temperature. The metals that are hardest to distinguish with a magnet are used in similar applications, have similar densities, and similar colors.

Chemical tests

Chemical tests listed in Table 1 are by no means complete but they are the common ones that can be performed in a shop with few simple chemicals. With your knowledge of other methods of identification, the chemical tests listed in Table 1 should be helpful to you in identifying metals.

Heat test

The heat test is used on steels to determine their ability to be hardened. This test will not identify the composition of steel but will determine whether or not the steel will harden. Heat treat a piece of steel as if it were of the composition which you believe it to be and quench it. It may harden and it may not. This test will not verify composition but will usually indicate whether or not the metals can be hardened.

Spark test

Spark testing is a common test that is used for the identification of ferrous metals (except titamium) but is rather unreliable. This test is best used for comparing an unknown specimen on a grinding wheel. This test will not identify stainless steel from carbon steels or steels containing a low carbon content. The spark test is very difficult to use to distinguish different alloys and in this respect is rather unreliable.

If the spark test is to be used to identify metals, it is important that equal pressure be applied to all pieces. A heavy continuous stream of sparks of bright intensity indicate that the wheel is cutting very fast. Sparks of less brightness at their source are an indication of a cooler cutting wheel.

The comparison chart (Table 2) and the sketches show the important differences among sparks from a wide variety of metals. The terms used are relative rather than absolute. The length of the spark stream depends on the pressure between the grinding wheel and the work. The apparent color depends upon the light in which the sparks are observed. The difference between red and orange, for example, is very slight. Each of these two colors might be called the other when one spark stream is observed without reference to the other.

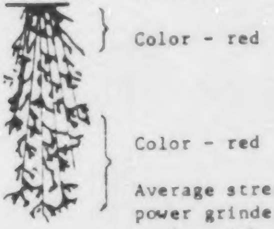
GRAY CAST IRON

I. Formation

- A. Approximate composition
  1. Iron
  2. Carbon 1.7 - 4.5%
  3. Silicon
     - a. 1.9 - 2.6%
     - b. Encourage graphite formation
  4. Sulfur
     - a. .06 - .12%
     - b. Undesirable element
  5. Phosphorus
     - a. .06 - .25%
     - b. Undesirable element
  6. Manganese
     - a. .70 - .90%
     - b. Neutralizes sulfur
  7. Other elements which are added for special properties - copper, nickel, aluminum, titanium, vanadium, molybdenum, and chromium.
- B. Procedure
  1. Metal is heated to 2750 degrees F.
  2. Poured into casting
  3. Cooled moderately slow to slow to encourage formation of
     - a. Pearlite and graphite
     - b. Pearlite and graphite and free ferrite
     - c. Ferrite and graphite
  4. Carbon is distributed between
     - a. Combined carbon - In pearlite
     - b. Uncombined or free carbon - In graphite
- C. Chip Test - no curl - free break
- D. Rough surface - gate and riser markings (from mold)

II. Identification

- A. Spark test - short streamers which are brick red and follow straight lines, with numerous fine, repeated yellow sparklers as shown in Figure 14.
- B. Appearance of fracture - dark gray porous structure



Average stream length with power grinder to 25 inches varies with pressure

Volume - small

Many sprigs followed by appendage

Figure 14. Spark appearance for gray cast iron.

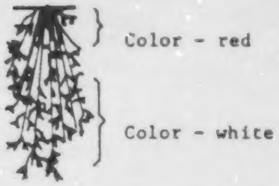
WHITE CAST IRON

I. The formation of white cast iron

- A. White cast iron has no free graphite.
- B. All of its carbon is combined as cementite or as pearlite.
- C. A low silicon content and rapid cooling rate are responsible for the structure of white cast iron.

II. The identification of white cast iron

- A. The fracture of white cast iron will disclose a fine, silvery white, crystalline formation.
- B. The spark test will show short streamers that are red in color, see Figure 15.
- C. There are fewer sparklers than in gray cast iron and these are small and repeating.
- D. The surface has the appearance of a sand mold and the surface is dark gray.
- E. Outer part of spark stream shows whiter spark from combined carbon.



Average stream length with power grinder to 20 inches varies with pressure

Volume - very small

Sprigs - finer than gray iron. small and repeating

Figure 15. Spark appearance for white cast iron.

CHILLED CAST IRON

I. Formation, identification and properties

- A. Its chemical composition is similar to gray, but has a lower silicon content.
- B. Chilled cast has thick surface section which is extremely hard and is resistent to wear - its interior structure is typical of gray cast.

C. The casting of chilled cast
   1. Cast against chilled iron surface
   2. The chilled surface quickly freezes the outer surface
   3. Creates a thick surface zone of extremely hard white iron free from graphite carbon
   4. Chilled zone may be changed
      a. To increase chilled zone decrease silicon content
      b. To decrease chilled zone increase silicon content

D. Identification similar to white cast iron.

MALLEABLE CAST IRON

I. Formation

A. Made by annealing white cast iron
   1. Temperature of 150 - 1650 degrees F.
   2. Annealing period of about 72 hours.
   3. Cementite decomposes leaving ferrite and graphite nodules.
   4. Most carbon is eliminated by diffusion and resultant product is ferritic.
   5. Carbon content varies from 2 - 5 percent.
   6. Existing carbon in the rounded or nodular form.

II. Identification and properties

A. Physical properties
   1. Dark gray color except for lighter outer layer (skin of steel)
   2. Evidences of sand mold on surface
   3. Spark tests (note Figure 16)
   4. a. Straw yellow color
      b. 30" stream length with powder grinder
      c. Moderate volume of sprigs
      d. Longer shafts than gray iron ending in numerous small sprigs
   4. Tensile strength of 30,000 to 53,000 psi
   5. Melting point of approximately 2300 degrees
   6. Malleable is stronger, tougher, more ductile than gray cast
   7. Chip test - chip curls some before breaking.

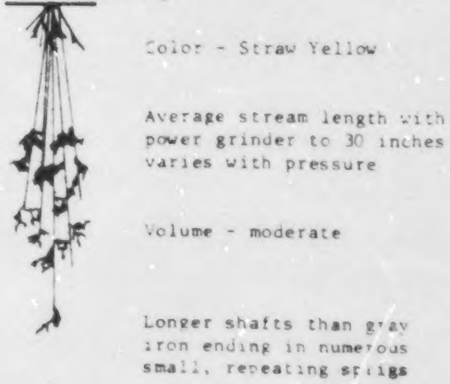

Color - Straw Yellow
Average stream length with power grinder to 30 inches varies with pressure
Volume - moderate
Longer shafts than gray iron ending in numerous small, repeating sprigs

Figure 16. Spark appearance for malleable iron.

NODULAR CAST IRON

I. Formation

A. By addition of magnesium and/or cerium as desulfurizer
   1. Added after the sulfur level was reduced to about 0.02%
   2. Added in the form of alloys
      a. Containing between 8 and 15% magnesium
      b. The rest of it is either nickel, nickel-silicon, copper-silicon or ferrosilicon
   3. Amount of magnesium added is influenced by the nature of the molten iron at the time of addition
   4. Above is followed by innoculation

B. Carbon precipitates as balls or spheres of graphite
   1. In a matrix of basically pearlite
   2. Some of the ferrite and free cementite is present

C. Three manufacturing processes
   1. By reladling into another ladle containing the magnesium alloy, then reladled back into original ladle as ferrosilicon innoculant is added to the stream.
   2. By pouring into ladle, which contains the alloy, from the furnace
      a. Innoculant is added as it is poured into mold
      b. Magnesium is volatile and precautions must be taken to prevent its loss
   3. 2 to 3 pounds of metallic magnesium can be added under pressure of 10-15 atmospheres to the molds
   4. Basic iron is formed in cupola
      a. Can produce sulfur contents of less than 0.02%
      b. Can utilize scrap metal
      c. Optimum carbon content range of 3.5% - 3.8%

II. Identification

A. Microstructures appear as spheres of graphite in a pearlite matrio.

B. To the eye it appears similar to medium carbon steel.

C. Tensile strength, 1. 60,000 to 150,000 psi which is higher than most cast irons.

D. Impact resistance as great as medium carbon cast steel.

E. More ductile than cast iron.

F. Properties closely resemble medium carbon steel.

G. As much as 10% elongation before fracture.

H. Spark appearance like gray cast iron except whiter color.

I. Chip test - chip curls some before breaking.

CARBON STEEL (HOT ROLLED)

I. Formation

A. Approximate composition

1. Iron - approximately 90% - depends on carbon content
2. Carbon - low to high .10% to 1.7%
3. Manganese - approximately .60%
4. Phosphorus - approximately .02%
5. Sulfur - approximately .02%
6. Silicon - approximately .08%

B. Procedure

1. Purification of pig iron - remove P, S and Si.
2. Decarburization to desired amount
3. Oxidation to speed process - BOF
4. Pour in ingot or continuous cast
5. Roll to desired shape

II. Identification

1. Chip test - curl
2. Fine grain - fracture - light gray
3. Spark test - white sparks - short lines with many sparks for high carbon - longer lines with fewer sparks for low carbon, see Figure 17.
4. Smooth surface from rolling

WROUGHT IRON

I. Formation

A. Approximate composition

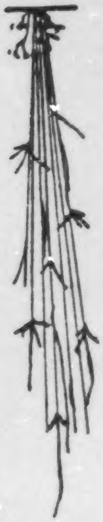
1. Iron	97%
2. Carbon	.02%
3. Manganese	.03%
4. Phosphorus	.12%
5. Sulphur	.02%
6. Silicon	.15%
7. Slag	3%

B. Procedure

1. Careful purification of pig iron
2. Decarburization
3. Molten metal poured into slag
4. Spongy mass squeezed in press
5. Iron silicate evenly distributed in fibrous form (wood-like)
6. Rolled to shape

II. Identification

1. Very ductile (like a nail)
2. Highly corrosion resistant
3. Chip test - definite curl
4. Sharp test - long lines - few sparks as illustrated in Figure 18.



LOW-CARBON STEEL
Color - Straw yellow

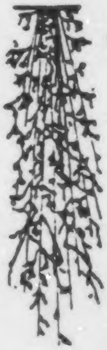
Average length of steam with power grinder varies with pressure

Volume - moderately large

Shafts shorter than wrought iron and in forks and appendages

Forks become more numerous and exploding sparks increase as carbon content increases

*These data apply also to cast steel.



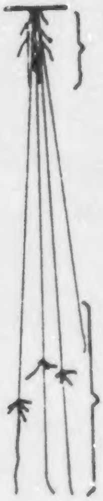
HIGH-CARBON STEEL
Color - white

Average stream length with power grinder to 55 inches varies with pressure

Volume - large

Numerous small and repeating exploding sparks

Figure 17. Spark appearance for low and high carbon steels.



WROUGHT IRON
Color - straw yellow

Average stream length with power grinder varies with pressure

Volume - large

Long shafts ending in forks and arrowlike appendages

Color - white

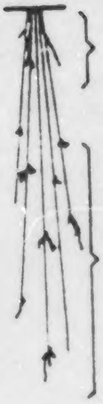
Figure 18. Spark appearance for wrought iron.

LOW AND HIGH ALLOY STEELS

I. Formation
- A. Approximate composition
  - 1. AESI-SAE classification chart shows many analyses. Iron and carbon content varies considerably.
  - 2. Alloying elements added to carefully made carbon steel for specific chemical, physical or mechanical characteristics.

II. Identification
- 1. Corrosion resistance (no rust)
- 2. Nonmagnetic (18-8 stainless steel)
- 3. Work harden - manganese steel
- 4. Spark test - seldom spark explosions as in carbon steel. Note Figure 19.
- 5. Sparks follow wheel
- 6. Volume of sparks usually low

ALLOY STEEL



Color - varies: yellow, red, white

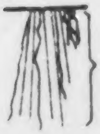
Stream length varies with types and amount of alloy content and pressure

Shafts may end in forks, buds, or arrows frequently with break between shaft and arrow. Few, if any, sprigs

Color - varies: white, red, yellow

**Spark shown is for stainless steel

NICKEL AND NICKEL ALLOYS



Color - orange

Average stream length with power grinder to 10 inches varies with pressure

Short shafts with no forks or sprigs

Figure 19. Spark appearance for alloy steels.

HARDNESS TESTING

Hardness is a property of a material which denotes resistance to permanent deformation. Thus hardness can be related to tensile stre in a non-destructive manner by heat treaters. Hardness can be indicated by the following methods:

1. Penetration hardness
   - a. Rockwell (most common in production)
   - b. Brinell
   - c. Vickers
2. Rebound (Vickers)
3. Scratch (Moh's)

The Rockwell hardness test measures the depth o penetration of a given penetrator under a speci fied load. The Rockwell B Test uses a 1/16" steel ball with loading applied in a manner tha measures the amount of indentation. The Rockwe C Test uses a diamond penetrator in a similar manner. Obviously the C test is used on harder materials than the B test. The C test measures to C76 which indicates beyond 387,000 psi TS. The B test measures to B111 which indicates 177,000 psi TS.

BRINELL HARDNESS-NUMBER CONVERSION. The Rockwe hardness numbers on the two standard hardness scales, B and C, can be converted into Brinell hardness numbers by the following equations, developed by Petranko at the U.S. Bureau of Standards. These equations are semiempiric and are accurate to within ± 10 percent.

For Rockwell numbers B 35 to B 100:

$$\text{Brinell hardness number} = \frac{7300}{130 - \text{Rockwell B number}}$$

For Rockwell numbers C 20 to C 40:

$$\text{Brinell hardness number} = \frac{1,420,000}{100 - \text{Rockwell C number}}$$

For Rockwell numbers greater than C 40:

$$\text{Brinell hardness number} = \frac{25,000}{100 - \text{Rockwell C number}}$$

Tensile Strength can be approximated as follow

$$\frac{\text{Brinell test number}}{2} \times 1000 = \text{TS psi in thousands}$$

Table 2. SPARK TEST CHARACTERISTICS OF METALS.

Metal	Volume of Stream	Relative Length of Stream, Inches	Color of Stream Close to Wheel	Color of Streaks Near End of Stream	Quantity of Spurts	Nature of Spurts
Wrought iron	Large	65	Straw	White	Very few	Forked
Machine steel	Large	70	White	White	Few	Forked
Carbon tool steel	Moderately large	55	White	White	Very many	Fine, repeating
Gray cast iron	Small	25	Red	Straw	Many	Fine, repeating
White cast iron	Very small	20	Red	Straw	Few	Fine, repeating
Annealed mall. iron	Moderate	30	Red	Straw	Many	Fine, repeating
High-speed steel	Small	60	Red	Straw	Extremely few	Forked
Manganese steel	Moderately large	45	White	White	Many	Fine, repeating
Stainless steel	Moderate	50	Straw	White	Moderate	Forked
Tungsten-chromium die steel	Small	35	Red	Straw	Many	Fine, repeating
Nitrided nitralloy	Large (curved)	55	White	White	Moderate	Forked
Stellite	Very small	10	Orange	Orange	None	. . . .
Cemented tungsten carbide	Extremely small	2	Light orange	Light orange	None	. . . .
Nickel	Very small	10	Orange	Orange	None	. . . .
Copper, brass, aluminum	None	. .	. . . .	. . . .	None	. . . .

Wrought iron can be bent and is quite ductile. When nicked and bent to the breaking point, the break is jagged. This iron has a fibrous structure and can be split in the direction in which the fibers run. It is easily cut with a chisel.

Gray cast iron gets its name from the fine specks of graphite dispersed through the metal. If you nick a corner of gray cast iron with a chisel, the break will be short and the exposed surface dark gray in color. The chips caused by the chisel will break off as soon as they are formed.

Malleable iron is much stronger than cast iron and does not break short when nicked with a chisel. The central portion of a broken surface of malleable iron is dark gray with a bright steel-like band around the edge similar to a picture frame.

Low-carbon steels are tough when chipped or nicked and the color is bright crystalline.

High-carbon steels are harder and more brittle than low-carbon steels and the fracture is whiter and finer grained.

Steel forgings may be of low-carbon, high-carbon, or tool steel and the color will vary from a bright crystalline to silky gray. When a specimen is nicked, it is harder to break than cast steel and it has a finer grain.

Cast steel is tough and does not break short. If you make chips with a chisel, they tend to curl up. Manganese steel cannot be cut with a chisel. The surface of fractured area of cast steel is bright crystalline.

Torch test

Many metals can be identified by observing the reaction of an oxyacetylene flame as it is applied to the metal.

Wrought iron melts quickly, with a slight tendency to spark. The melted iron has a greasy or oily appearance and a slag that is marked with white lines.

Gray cast iron has a heavy, tough film that forms on the surface as it melts. The puddle is very fluid and, as the torch flame is removed, the depression in the surface of the puddle disappears instantly. The molten puddle solidifies slowly and does not give off sparks.

Molten malleable iron boils under the torch flame and, when the flame is withdrawn, the surface is full of blowholes. The melted part cools very hard and brittle. It is, in fact, white or chilled cast iron that is produced by the melting and comparatively rapid cooling. The outer, steel-like shell will give off sparks under the torch. The center portion of the puddle will not.

Steel forgings spark when melted. The greater the carbon content, the greater the number and the brilliance of the sparks.

Low-carbon steels give off sparks when melted and solidify almost instantly when the flame is removed.

High-carbon steels appear brighter when molten than the low-carbon steels and the melted surface has a cellular appearance.

Cast steel gives off steel sparks when melted and solidifies very quickly.

Hardness testing

Testing a metal for hardness may be done to determine the ability of a material to resist penetration, deformation, or wearing away due to an abrasive action. Hardness testing is also used to help determine an approximate tensile strength value. Non ferrous alloys, however, cannot be converted into tensile strength values.

The hardness of a metal depends on various factors, physical properties, heat treatment, method of fabrication, and others. Hardness is directly related to other properties, such as tensile strength and toughness. The international standard of measurement of hardness is called the "Rockwell" test. It is based on the amount of depth penetration that results from increasing the minor load pressure to the major load pressure in a testing machine. The minor load pressure (10 kg.) is applied to seat the penetrator, followed by the major load pressure (60-150 kg). The hardness reading is a measurement of the increment between the two loads. The principle is the same whether a diamond penetrator or a steel ball is used.

Other types of machines, such as the "Brinnell" and "Vickers" operate on the principle of applying a known weight to a known size of penetrator. A 10 mm. steel ball is used for the Brinnell test and a pyramid diamond for the Vickers. The area of penetration is then measured to determine the hardness.

Mechanical properties and chemical composition of various ferrous metals.

Material	Spec.	Chemical analysis			Mechanical properties			
		Carbon	Others		Yield strength	Tensile strength	Elongation % in 2 in.	Brinell hardnes
Cast iron, gray, grade 20	ASTM A48-56	3.00–4.00			...	20,000	...	163
gray grade 30	ASTM A48-56	3.00–4.00			...	30,000	...	180
nickel		2.00–3.50	Nickel 0.25–0.50		...	40,000	...	310
chrome–nickel		2.00–3.50	Nickel 1.00–3.00	Chromium 0.50–1.00	...	53,000	...	510
white		2.00–4.00	Silicon 0.80–1.50		...	46,000	...	420
malleable	ASTM A47-52	1.75–2.30	Silicon 0.85–1.20		35,000	53,000	18	140
Iron, wrought, plates	ASTM A42-55	0.08	Silicon 0.15	Slag 1.20	26,000	46,000	35	105
Iron, wrought, forgings	ASTM A75-55	0.01–0.05	Iron 99.45–99.80		25,000	44,000	30	100
Steel, cast, low carbon		0.11	Manganese 0.60	Silicon 0.40	35,000	60,000	22	120
Steel, cast, medium carbon		0.25	Manganese 0.68	Silicon 0.32	44,000	72,000	18	140
Steel, cast, high carbon		0.50			40,000	80,000	17	182
Steel, rolled, carbon	SAE 1010	0.05–0.15			28,000	56,000	35	110
Steel, rolled, carbon	SAE 1015	0.15–0.25			30,000	60,000	26	120
Steel, rolled, carbon	SAE 1025	0.20–0.30			33,000	67,000	25	135
Steel, rolled, carbon	SAE 1035	0.30–0.40			52,000	87,000	24	175
Steel, rolled, carbon	SAE 1045	0.40–0.50			58,000	97,000	22	200
Steel, rolled, carbon	SAE 1050	0.45–0.55			60,000	102,000	20	207
Steel, rolled, carbon	SAE 1095	0.90–1.05			100,000	150,000	15	300
Steel, rolled, nickel	SAE 2315	0.10–0.20	Nickel 3.25–3.75		90,000	125,000	21	230
olled, nickel–chromium	SAE 3240	0.35–0.45	Nickel 1.50–2.00	Chromium 0.90–1.25	113,000	136,000	21	280
Steel, rolled, molybdenum	SAE 4130	0.25–0.35	Chromium 0.50–0.80	Molybdenum 0.15–0.25	115,000	139,000	18	280
Steel, rolled, chromium	SAE 5140	0.35–0.45	Chromium 0.80–1.10		128,000	150,000	19	300
Steel, rolled, chromium–vanadium	SAE 6130	0.25–0.35	Chromium 0.80–1.10	Vanadium 0.15–0.18	125,000	150,000	18	310
Steel, rolled, silicon–manganese	SAE 9260	0.55–0.65	Manganese 0.60–0.90	Silicon 1.80–2.20	180,000	200,000	12	[illegible]

Uses for steel by carbon content.

Carbon class	Carbon range %	Typical uses
Low	0.05–0.15	Chain, nails, pipe, rivets, screws, sheets for pressing and stamping, wire
	0.15–0.30	Bars, plates, structural shapes
Medium	0.30–0.45	Axles, connecting rods, shafting
High	0.45–0.60	Crankshafts, scraper blades
	0.60–0.75	Automobile springs, anvils, bandsaws, drop hammer dies
Very high	0.75–0.90	Chisels, punches, sand tools
	0.90–1.00	Knives, shear blades, springs
	1.00–1.10	Milling cutters, dies, taps
	1.10–1.20	Lathe tools, woodworking tools
	1.20–1.30	Files, reamers
	1.30–1.40	Dies for wire drawing
	1.40–1.50	Metal cutting saws

The James F. Lincoln Arc Welding Foundation

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INDEX FOR AISI-SAE STEEL SPECIFICATION NUMBERS

etter "X" in Specification No. indicates digit which changes with different types)

Classifications		Specification numbers
Carbon Steels		10XX
Carbon Steels, Resulfurized		11XX
Carbon Steels, Rephosphorized and Resulfurized		12XX
Manganese Steels		13XX
Nickel Steels		2XXX
Nickel-Chromium Steels		31XX
High Nickel-Chromium Steels		33XX
Carbon-Molybdenum Steels		40XX
Chromium-Molybdenum Steels		41XX
Chromium-Nickel-Molybdenum Steels		43XX
Nickel-Molybdenum Steels		46XX
High Nickel-Molybdenum Steels		48XX
Low Chromium Steels		50XX
Chromium Steels		51XX
Carbon-Chromium Steels		52XXX
Chromium-Vanadium Steels		61XX
Low Nickel-Chromium-Molybdenum Steels		86XX
Low Nickel-Chromium-Molybdenum Steels		87XX
Silicon-Manganese Spring Steels		92XX
Silicon-Manganese-Chromium Spring Steels		92XX
Nickel-Chromium-Molybdenum Steels		93XX
Nickel-Chromium-Molybdenum Steels		98XX
Boron Containing Steels		XXBXX
Boron-Vanadium Containing Steels		XXBVXX
Water-Hardening Tool Steels		WX
Shock-Resisting Tool Sheets		SX
Oil-Hardening Tool Steels		OX
Air-Hardening Tool Steels	Cold work	AX
High-Carbon, High-Chromium Tool Steels		DX
Hot-Work Tool Steels		HXX
High-Speed (Tungsten Base) Tool Steels		TX
High-Speed (Molybdenum Base) Tool Steels		MX
Special Purpose Tool Steels		LX
Carbon-Tungsten Tool Steels		FX
Mold Steels		PX
Chromium-Nickel-Manganese Stainless Steels		2XX
Chromium-Nickel Stainless Steels		3XX
Chromium Stainless Steels		4XX
Low Chromium Heat-Resisting Steels		5XX

AISI (Only) High-Temperature, High-Strength Allovs

Martensitic Low Alloy Steels	60X
Martensitic Secondary Hardening Steels	61X
Martensitic Chromium Steels	61X
miaustenitic Precipitation and Transformation Hardening Steels	63X
Austenitic Steels Strengthened by "Hot-Cold" Work	65X
Austenitic Alloys, Iron Base	66X
Austenitic Alloys, Cobalt Base	67X
Austenitic Alloys, Nickel Base	68X, 69X

The American Iron and Steel Institute steel quality classification system is shown below.

AISI STEEL DESIGNATION SYSTEM

Prefix and Suffix Letters

Prefix letter	Meaning
A	Basic Open-Hearth Alloy Steel
B	Acid Bessemer Carbon Steel
C	Basic Open-Hearth Carbon Steel
D	Acid Open-Hearth Carbon Steel
E	Basic Electric Furnace Steel
TS	Tentative Standard Steel
Q	Forging Quality, or Special Requirements
R	Re-rolling Quality Billets

Suffix letter	Meaning
A	Restricted Chemical Composition
B	Bearing Steel Quality
C	Guaranteed Segregation Limits
D	Specified Discard
E	Macro-Etch Tests
F	Rifle Barrel Quality
G	Limited Austenitic Grain Size
H	Guaranteed Hardenability
I	Non-Metallic Inclusions Requirements
J	Fracture Test
T	Extensometer Test
V	Aircraft Quality or Magnaflux Testing

Identification of steel for warehouse purposes by means of paint applied usually by spray can on the ends of steel bars. Unfortunately all colors are not standardized in the industry.

Common Steel Color Designations:

Color designation is not completely standardized by the steel industry or by manufacturers. The color is usually sprayed on the ends of the steel bars. The following are the color designations used by a steel supplier. (Ryerson)

Green - C 1015 to C 1025
Blue - C 1035
Yellow - C 1040 to C 1045
Pink - C 1095
Brown - C 1140
Gold - C 1117
White - B 1112
Orange - B 1113

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EFFECT OF ALLOYING ELEMENTS
ON STEEL

Carbon

Iron + Carbon = steel

Increased carbon - increase heat treatment response

- more tensile strength

- more hardness

- less ductility

C .10% - .25% - mild, ductile, tough, low strength; no heat treatment response; carburizable with soft core; S & P .05%; machinability poor - too soft, tears

C .25% - .40% - harder; good machining qualities

C .30% - .40% - good response to heat treatment

C .40% - .60% - high hardening response to heat treatment; too hard for machining unless annealed

C .60% -1.75% - very easily hardened by heat treatment
- resists abrasion
- brittle
- difficult to machine; too hard

C over 1.5% - approaches properties of cast iron

Manganese

Contained in all steel from .20% - 14%
- up to .80% acts as a deoxidizer and scavenger
- .80% - 2% acts as deoxidizer
- excess forms carbides

Mn Carbides - increase steel tensile strength
- increase response to heat treatment
- increase cold working ability compared to carbon steel of same strength

11.5% - 14% - increased abrasion resistance
- has work hardening properties
- loss of heat hardening response
- can be toughened by high heat and quenching
- ductile (impact resistant)
- abrasion resistant (work hardening)

Sulfur

Generally considered undesirable

AISI = .02% elect process
.04% open hearth

.06% - .30% - improved machinability; chips break off
- no adverse affect on strength

Iron sulfides melt at 2500°F (solidifies)

Steel melts at 2700°F (solidifies)

Manganese @ 7-9X sulfur = Mn sulfidies melt @ 2900°F

Mn removes the problem of - sulfides staying molten and forming weak spots along steel grain lines upon cooling the steel

Phosphorus

All steels have some phosphorus; considered undesirable - causes brittleness in steel

Good effects - increased strength; reduce ductility
- reduced corrosion in air of steel

P + Copper - better machinability, < .05%

.045% up to .13%

Silicon

(up to 2.5% Si)

- deoxidizer, cleaner
- refines grain
- increases tensile strength without decrease in ductility

Special silicon electrical steels
over 2.5% Si alloys - have desirable magnetic properties for use in electrical appliances, generators, transformers, motors

over 13% - non ductile, non machinable
- highly resistant to corrosive acids and other corrosive materials

May be added to stainless steel to reduce oxidation at high temperatures and improve certain types; corrosion resistance

Nickel

1% - 5% - increase strength and ductility
up to 15% - special stainless steels
up to 60% - resistance to high temperatures
- high impact resistance at very low temperatures

Chromium

Increased response to heat treatment
- for hardening
- increases depth of hardening toward core of steel object

Used in stainless steel - heat resistance

5% - 40% in stainless steels

.25% - 12% in tool steels

Molybdenum

Small amounts are needed

- increases depth of hardening
- increases toughness in heat treated steel
- improves machinability of hard steels
- helps retain strength and reduces stretching at high temperatures
- reduces corrosion in stainless steel
- improves ductility at sub 0° temperatures, especially when used with nickel

Vanadium

- resists grain growth when steels are over heated
- deoxidizer and cleanser
- improves tensile strength

.15% - .1% - improves shock and impact resistance

Aluminum

- most active deoxidizer and cleanser
- increases fineness of grain
- increases response of steel to nitriding process

Tungstun

- refines grain
- improves density of structure of steel
- allows for very keen edging (sharpening)

14% - 20% + other alloys = high speed tool steel work
strength at high temperatures - cutting
(used in valves and valve seats in engines);
used with chromium and other alloying elements

General

Three different equally effective alloys have more effect when used in combination than 3X one used alone. Also more dependable effects.

Reference

Alloy Steel Reference Book by Ryerson Steels. Joseph T. Ryerson & Sons, Inc., N.Y.

CARBON CONTENT, CHARACTERISTICS AND COMMON USES OF IRON AND STEEL

Designation	% Carbon	SAE Classification Number	Characteristics	Common Uses	Color Code
Wrought Iron	.02-.03		High ductility, easily worked cold and welded. High corrosion resistance.	Waterpipe, rivets	
Low Carbon	.05-.30		Easily worked refined iron.	Bolts, better grades of water pipe, rivets, nails, wire sheet metals	
Medium Carbon	.30-.45		Malleable steel, easily worked.	Agricultural machinery, bars, plates, rails, structural shapes.	
High Carbon Steel	.45-.75		High quality steel, which may be hardened by cooling suddenly, may contain some manganese or other elements.	Screw drivers, pliers, drive shafts, crankshafts.	
Very High Carbon	.75-1.00			Chisels, punches, tools knives, springs	
	1.0-1.2			Lathe tools, dies, taps	
	1.2-1.7			Files, reamers, metal cutting saws	
High Speed Steel	.55-.85		Contains carbon with varying amounts of cobalt, molybdenum, and tungsten. Withstands heat resulting from cutting at high speeds. Tools cost from 2 to 3 times carbon steel.	Drills, taps, dies, lathe tools, milling cutters and reamers	
Gray Cast Iron	1.7-4.5		Alloy of iron with free carbon (graphite) and silicon, brittle, resists rust.	Agricultural machinery, casting, stoves, engine blocks	
Chilled (white) Cast Iron	1.7-3.75		Combined carbon, very hard and brittle. High wear resistance.	Disc and rotary hoe bearings	
Malleable Cast Iron	1.7		Combined carbon of white cast iron changed to graphite carbon by 50 hour heat treatment. Resists shock and has higher tensile strength than ordinary cast. May be considered as gray or white cast with a steel-like layer on the outside, thus bending slightly without breaking.	High strength - agricultural machinery parts, some tools, castings	
Ductile Cast Iron (Nodular, Spheroidal)	3.44-3.88 (Nickel 1.5% Magnesium or cerium .1-.15%)		High ductility, 8 times that of gray cast, good machinability, shock resistant.	Replaces gray and malleable cast and unusual steel shapes	

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REPRESENTATIVE ALLOYS AND STAINLESS STEELS COMPARED WITH CARBON STEEL

Representative Types of Steel	INDEX OF MECHANICAL PROPERTIES (Compared with carbon steel) Breaking Strength	Relative Elasticity	Ductility	Hardness	Distinguishing Characteristics	Typical Uses
A. CARBON STEEL 1. (C-0.40%)	100	100	100	100	Good strength and workability	Railroad track bolts, auto axles, brake levers, bicycle pedals
B. ALLOY STEELS HEAT TREATED 1. MEDIUM MANGANESE (Mn 1.75%)	145	155	58	138	Good strength and workability	Logging, road and agricultural machinery
2. 3½% NICKEL-MOLYBDENUM (Ni 3.5, Mo 0.25%)	202	224	63	192	Good strength and toughness	Rock-drill and air-hammer parts, high-duty gears
3. CARBON-VANADIUM (V-0.18%)	158	179	68	153	Resists impact	Locomotive parts, hand tools
4. CARBON MOLYBDENUM (Mo 0.50%)	149	162	53	164	Resists heat	Oil refining and high-pressure steam equipment
5. SILICON-MANGANESE (Si 2.00, Mn 0.75%)	198	224	42	180	Springiness	Auto and railroad car springs
6. PLAIN CHROMIUM (Cr 0.95%)	157	177	63	147	Good strength and workability	Springs, shear blades, wood cutting tools
7. CHROMIUM-NICKEL (Cr 0.60, Ni 1.25%)	115	125	94	120	Surface easily hardened	Auto ring gears, pinions, piston pins, transmission
8. CHROMIUM-VANADIUM (Cr 0.95, V-0.18%)	202	229	52	225	High strength and hardness	Automobile gears, propeller shafts, connecting rods
9. CHROMIUM-MOLYBDENUM (Cr 0.95, Mo 0.20%)	130	135	94	125	Resists impact, fatigue and heat	Aircraft structures, missile parts
10. NICKEL-MOLYBDENUM (Ni 1.75, Mo 0.35%)	155	177	68	153	Resists fatigue surface easily hardened	Railroad roller bearings, auto transmission gears
11. MANGANESE-MOLYBDENUM (Mn 1.30, Mo 0.30%)	158	177	68	151	Good strength and toughness	High-pressure tanks
12. NICKEL-CHROMIUM-MOLYBDENUM (Ni 1.75, Cr 0.65, Mo 0.35%)	158	203	63	161	High strength	Aircraft engine and landing gear parts
C. STAINLESS STEEL 1. 18-8 STAINLESS (Cr 18, Ni 8%) (Cold worked)	207	219	53	165	Resists corrosion	Food machinery, kitchenware, railroad cars, building panels
D. ALLOY SHEET STEEL 1. HIGH SILICON SHEETS (Si 4.00%)		Electrical Properties of Prime Importance			High electrical efficiency	Transformers, motors, generators
E. ALLOY TOOL STEEL 1. HIGH SPEED STEEL (Tungsten 18, Cr 4, V-1.0%)		Cutting Properties of Prime Importance			Stays hard at high temperature	High-speed metal-cutting tools
F. ALLOY MAGNET STEEL 1. COBALT MAGNET STE[illegible] (Co 35.0%)		Magnetic Properties of Prime Importance			High magnetic strength	Permanent magnets in electrical apparatus

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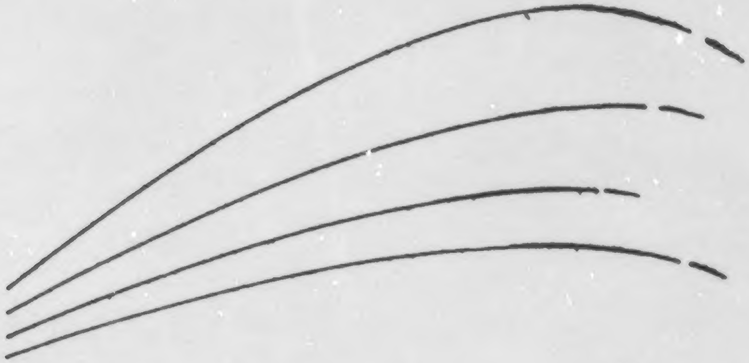
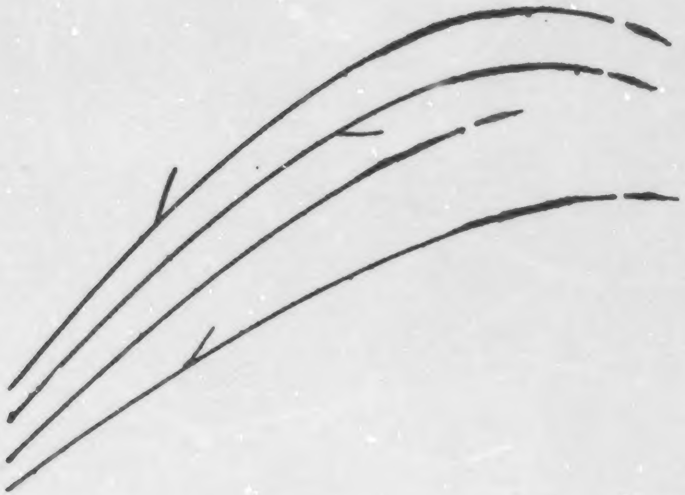
SPARK PATTERN FROM WROUGHT IRON

AgIII-IX-18



SPARK PATTERN FROM LOW CARBON STEEL

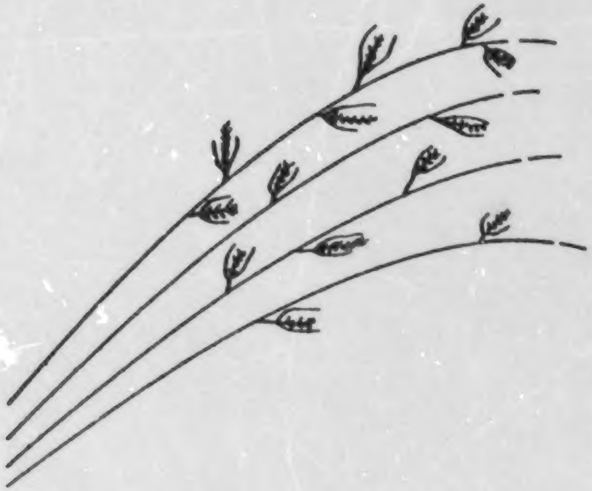


Ag111-IX-19

Vocational Agriculture Service – College of Agriculture – University of Illinois at Urbana-Champaign (Arc Welding 7)

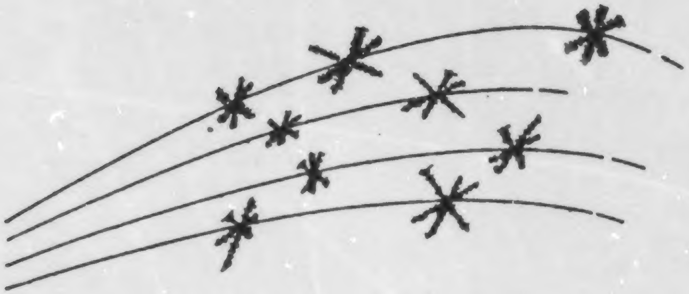
SPARK PATTERN FROM MEDIUM CARBON STEEL

AgIII-IX-20



Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana-Champaign (Arc Welding 6)

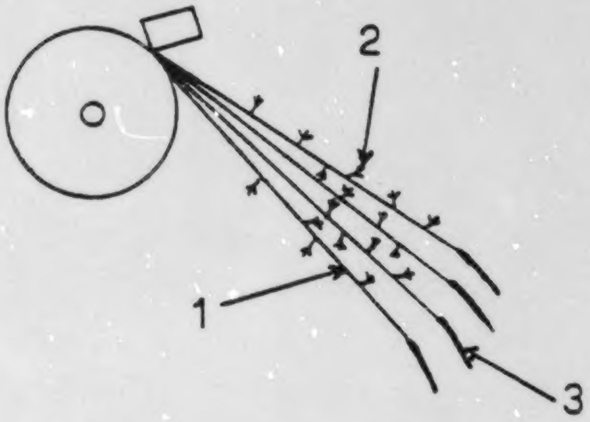
SPARK PATTERN FROM HIGH CARBON STEEL



AgIII-IX-21

AgIII-IX-22

METALS IDENTIFICATION



Identification

1. ____________________
2. ____________________
3. ____________________

Methods of Identifying Metals

Spark test
Color
Weight
Surface texture
Texture of a break
Shape
Use
Sound when tapped
Forge marks
Cast marks

Exercise Teaches: (Ability to...
(Understanding of...

1. U..characteristics which lead to metal identification.
2. A..identify non-ferrous metals.
3. A..identify ferrous metals.
4. A..identify steels.
5. A..identify the carbon content of steels.
6. A..identify the various cast irons.

Name____________________

Date____________________ Grade______

Metal Identification Exercise

Identify the metal samples provided and give the carbon content where applicable.

	Type of Metal	% C.
A.	____________	______
B.	____________	______
C.	____________	______
D.	____________	______
E.	____________	______
F.	____________	______
G.	____________	______
H.	____________	______
I.	____________	______
J.	____________	______

Spark Testing

Hold the metal sample with moderate pressure against the grinding wheel and observe the sparks given off.

No sparks = non-ferrous metal
Long iron lines = low C steel
Short iron lines = High C steel
Few explosions = low C content
Many explosions = High C content
Straw colored iron lines = steel
Red iron lines = cast iron
Curved appendages on iron lines = cast iro

Evaluation Score Sheet

Item	Points Possible	Earned
Identification of carbon content (3 each)	15	______
Identification of samples (7 each)	70	______
Attitude and work habits	15	______
Total points	100	______

Electrode Selection:

Once a metal which must be repaired is properly identified the correct electrode must be selected.

The following chart is available from Lincoln Electric and provides a means for electrode selection.

For this unit, the following electrode selections should be made:

1. Medium and High Carbon Steel - Low Hydrogen AWS E7018 - best perform received on DC+ however AC machines with high open circuit voltage may be used. Use amperage ranges identified on the cahrt.
2. Gray cast iron - for most applications the greatest success woll be received by using a nickel alloy rod. Lincoln's number is ENI-C1, Eutechic has three rods one is 98% nickel and the others are 99% nickel. Use good quality rods if you expect the weld job to stay together.
3. Aluminum welding is best performed with a TIG

ELECTRODE IDENTIFICATION AND OPERATING DATA

The current ranges given represent minimum and maximum metered currents for which each electrode is designed. Actual machine setting is influenced by plate thickness, joint position and operator preference.

COATING COLOR	IDENTIFICATION MARKING			Conforms to Test Requirements of AWS Class	ELECTRODE	POLARITY (+) = "REVERSE" (−) = "STRAIGHT"	SIZES AND CURRENT RANGES (Amps.)			
	(E) END	(S) SPOT	(L) or AWS No.				3/32" SIZE	1/8" SIZE	5/32" SIZE	3/16" SIZE
MILD STEEL										
Light Tan				E6010	Fleetweld® 5	DC (+)		75-130	90-175	140-225
Brick Red				E6010	Fleetweld 5P	DC (+)	40-75	75-130	90-175	140-225
Tan		White		E6012	Fleetweld 7	DC (−) AC		80-135 90-150	110-180 120-200	155-250 170-275
Light Tan		Blue		E6011	Fleetweld 35	AC DC (+)		75-120 70-110	90-160 80-145	120-200 110-180
Red Brown		Blue		E6011	Fleetweld 35LS	AC DC (±)		80-130 70-120	120-160 110-150	
Dark Tan		Brown		E6013	Fleetweld 37	AC DC (±)	75-105 70-95	100-150 90-135	150-200 135-180	200-260 180-235
Gray-Brown	Black	Brown		E7014	Fleetweld 47	AC DC (−)		110-160 100-145	150-225 135-200	200-280 180-250
Brown		Brown	Lincoln Dot	E6013	Fleetweld 57	AC DC (±)	75-105 70-95	100-150 90-135	150-200 135-180	200-260 180-235
Brown		Blue		E6011	Fleetweld 180	AC DC (+)	40-90 40-80	60-120 55-110	115-150 105-135	
Gray	Black	Yellow		E7024	Jetweld® 1	AC DC (±)	65-120 60-110	115-175 100-160	180-240 160-215	240-300 220-280
Brown		Silver		E6027	Jetweld 2	AC DC (±)			190-240 175-215	250-300 230-270
Gray- Black	Black	Yellow	Lincoln Dot	E7024	Jetweld 3	AC DC (±)		115-175 100-160	180-240 160-215	240-315 215-285
Gray			7018	E7018	Jetweld LH-70	DC (+) AC	70-100 80-120	90-150 110-170	120-190 135-225	170-280 200-300
Gray				7018	Jet-LH® 72	DC (+) AC	70-100 80-120	85-150 100-170	120-190 135-225	170-250 180-280
Gray-Brown			7028	E7028	Jetweld LH-3800	AC DC (+)			180-270 170-240	240-330 210-300
LOW ALLOY, HIGH TENSILE STEEL										
Pink	Blue	White		E7010-A1	Shield-Arc® 85	DC (+)	50-90	75-130	90-175	140-225
Pink	Blue		Green	E7010-G	Shield-Arc 85P	DC (+)				140-225
Tan			7010-G	E7010-G	Shield-Arc HYP	DC (+)		75-130	90-185	140-225
Tan			8010-G	E8010-G	Shield-Arc X75	DC (+)		75-130	90-185	140-225
Dark Red	Blue	Orange		E7027-A1	Jetweld 2-HT	AC DC (∓)			190-240 175-215	250-300 230-270
Gray-Brown			8018-C1	E8018-C1	Jet-LH® 8018-C1	DC (+) AC		90-150 110-160	120-180 140-200	180-270 200-300
Gray-Brown			8018-C3	E8018-C3	Jet-LH 8018-C3	DC (+) AC		90-150 110-160	120-180 140-200	180-270 200-300
Gray			8018-B2	E8018-B2	Jetweld LH-90	DC (+) AC		90-150 110-160	110-200 140-230	160-290 200-310
Gray			11018-M	E11018-M	Jetweld LH-110	DC (+) AC		95-155 115-165	120-200 145-230	160-280 200-310
STAINLESS STEEL										
Pale Green	Yellow		308-15	E308-15	Stainweld® 308-15	DC (+)	30-70	50-100	75-130	95-165
Gray	Yellow		308-16	E308-16	Stainweld 308-16	DC (+); AC	30-60	55-95	80-135	115-165
Gray	Brown		308L-16	E308L-16	Stainweld 308L-16	DC (+); AC	30-65	55-100	80-140	115-190
Pale Green	Red		310-15	E310-15	Stainweld 310-15	DC (+)	30-70	45-95	80-135	100-165
Gray	Red		310-16	E310-16	Stainweld 310-16	DC (+); AC	30-65	55-100	85-140	120-185
Gray	Brown	White	316L-16	E316L-16	Stainweld 316L-16	DC (+); AC	30-65	55-100	80-140	115-190
Pale Green	Yellow	Blue	347-15	E347-15	Stainweld 347-15	DC (+)	30-70	50-100	75-130	95-165
Gray	Yellow	Blue	347-16	E347-16	Stainweld 347-16	DC (+); AC	30-60	55-95	80-135	115-165
BRONZE & ALUMINUM										
Peach	Yellow	Blue		E-CuSn-C	Aerisweld®	DC (+)		50-125	70-170	90-220
White				Al-43	Aluminweld®	DC (+)	20-55	45-125	60-170	85-215
CAST IRON										
Light Tan	Orange			ESt	Ferroweld®	DC (+); AC		80-100		
Black	Orange	Blue		ENi-CI	Softweld®	DC (±) AC		60-110 65-120	100-135 110-150	
HARDSURFACING										
Black					Abrasoweld	DC (±) AC		40-150 50-165	75-200 80-220	110-250 120-275
Slate	Yellow				Faceweld® 1	DC (+); AC				60-150
Slate	Pink				Faceweld 12	DC (+); AC				60-150
Dark Grey					Jet-LH BU-90	DC (±) AC			145-210 155-225	180-280 200-290
Dark Grey	Orange	Red			Mangjet®	DC (±) AC			170-180 135-230	160-260 165-285
Dark Grey					Wearweld®	DC (+) AC				110-275 125-275

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Shaded areas indicate electrode sizes NOT recommended for the AC-225-S.

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Welding Medium and High Carbon Steel:

1. Welding procedure for medium and high carbon steel is essentially the same for low carbon steel.

2. The electrode used must be low hydrogen AWS E7018, E7028, E8018, E9018, E11018. See "Electrode Identification and Operating Data" chart for amperage settings. That chart proceeds this page.

3. Welding with 7018 electrode is best accomplished on a DC+ setting. AC machines may be used if they have a high open circuit voltage (80 OCV or higher). Even with a high open circuit voltage the 7018 rod will be difficult to strike an arc with, it will however, run well once the arc is struck.

4. AWS E7018 electrodes flux must be dry when the rod is used. See the following instructions for maintaining dry rod.

LINCOLN ELECTRIC

M629

REDRYING

Low Hydrogen Electrodes

Low hydrogen electrodes must be dry to perform properly. Electrodes in unopened Lincoln hermetically sealed containers remain dry indefinitely in good storage conditions. Opened cans should be stored in a cabinet at 250 - 300°F.

Supplying welders with electrodes normally twice a shift - such as at the start of the shift and at lunch - will provide efficient production with little danger of moisture pickup. Return rod to the heated cabinet overnight.

When containers are punctured or opened so the electrode is exposed to the air for a few days, or when containers are stored in unusually wet conditions, low hydrogen electrodes will pick up moisture. Depending upon the amount of moisture, it will damage weld quality in the following ways:

1. A small amount of moisture may cause internal porosity. Detection of this condition requires X-ray inspection or destructive testing. If the base metal has high hardenability, even a small amount of moisture can contribute to underbead cracking.
2. A relatively high amount of moisture causes visible external porosity in addition to internal porosity.
3. Severe moisture pick up can cause weld cracks or underbead cracking in addition to severe porosity.

Redrying completely restores the electrodes' ability to deposit quality welds. The proper redrying temperature depends upon the type of electrode and its condition as listed here. The first condition is by far the most common.

Condition	Drying Temperature Jetweld E7018 & E7028	Drying Temperature Jetweld E8018, 9018, 11018
1. Electrodes exposed to air for less than one week; no direct contact with water. Welds not subject to X-ray inspection.	300°F	300°F
2. Electrodes exposed to air for less than one week; no direct contact with water. Welds subject to X-ray inspection.	700°F	750°F
3. Electrodes which have come in direct contact with water, or which have been exposed to extremely humid conditions as indicated by core wire rusting at the holder end. *	700°F	750°F

* Before redrying at 700 - 750°F pre-dry electrodes in this condition at 180°F for 1 to 2 hours. This minimizes the tendency for coating cracks or oxidation of the alloys in the coating.

One hour at the listed temperatures is satisfactory. Do not dry electrodes at higher temperatures or for more than 3 hours. Several hours at lower temperature is not equivalent to using the specified temperatures. Remove the electrodes from the can and spread them out in the furnace because:

1. Each electrode must reach the drying temperature.
2. The cardboard can liners char at about 350°F.

Because many variables in design, fabrication, and erection affect the results obtained in applying this type of information, the serviceability of a product or structure is the responsibility of the builder.

LINCOLN ELECTRIC THE LINCOLN ELECTRIC COMPANY
World's Largest Manufacturer of Arc Welding Equipment and Electrodes · Manufacturer of Motors Since 1895
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Welding Gray Cast Iron:

1. Gray cast iron is the most common kind of cast iron used. As such the welding procedures identified are applied to gray cast iron. Common uses of gray cast iron are engine blocks, transmission housings, large external gears (i.e. manure spreader driver gears), etc.

2. White cast iron is extremely hard and resistant to wear. It is used as disc gang bearings and other high potential of soil impaction and low maintenance possibilities. White cast iron is virtually non-weldable.

SPECIAL WELDING APPLICATIONS

Cast Iron

It is important to recognize cast iron and to know how it acts under heat in order to weld it successfully. Bringing cast iron up to welding temperature, welding a small area, and allowing the metal to cool may cause immediate cracking or cause uneven expansion and contration which results in later cracks. Sudden cooling from the welding temperature causes iron to be hard and brittle as a small area of white cast iron is formed around the weld. More care must, therefore, be taken when welding cast iron than with the mild steel on which you have been welding.

Most of the cast iron that breaks and needs repair is gray cast iron. White or chilled cast iron is not encountered very often and is quite difficult to weld. Malleable cast iron can be successfully welded but malleable iron parts do not break as frequently as gray cast iron parts because malleable iron is stronger and tougher. When welding a malleable casting, the zone next to the weld that is heated above the critical temperature reverts back to a brittle material.

Two general types of electrodes are used for arc welding cast iron--the "machinable", and "nonmachinable" types. Machinable electrodes are nearly pure nickel. They are easy to use and produce a weld that is soft enough to be sawed, drilled, filed, or machined in any way. The non-machinable electrode is made of mild steel with a special flux for welding cast iron. It is less expensive than the highnickel machinable type but produces a weld that is very hard and cannot be filed, sawed, drilled, or otherwise machined. It can, of course, be ground to shape.

The choice of electrode depends on the nature of the welding job. For the all around repair of small castings, where the amount of electrode used is small so that the difference in cost is not great, most welders prefer to use the high-nickel electrode. It is somewhat easier to apply and produces a soft weld that is less brittle than that made by the non-machinable electrode.

The amperage setting for the welder should be made according to the directions on the electrode package. As a general rule, use 90 to 125 amperes for 1/8" machinable or nonmachinable electrodes, depending on the thickness of the base metal. Running a bead on a scrap casting of similar thickness is helpful in obtaining the correct amperage setting. If the amperage is too low, the arc is difficult to maintain and the bead tends to "pile up". If amperage is too high the weld will noil and bubble excessively and cut in too deeply. Use a slightly longer arc length than for mild-steel welding and a side-to-side weave to aid fusion along the edges of the bead. The correct current is the lowest that has adequate penetration.

Castings may be welded "hot" or "cold". Whenever possible, welding a casting "hot" is the most satisfacttory method. This method minimizes uneven expansion and contraction and speeds up the welding process. Preheat the entire casting to a dull red color and maintain this or a slightly lower temperature until the welding is complete. Preheating removes any grease or oil which has soaked into the porus casting and prevents gas pockets or pits in the weld bead. Small castings can be preheated easily with the carbon-arc torch. Large castings may require building an enclosure or furnace around them with fire brick or asbestos. This helps hold and confine the heat during preheating and welding.

Preheating also permits faster welding, and assures closer alignment of the structure after the weld is completed and has cooled.

By knowing what members to preheat, most of the stresses and strains can be eliminated. Fig. 18-13. If the casting is flat, it is best to weld it on both sides to prevent warping.

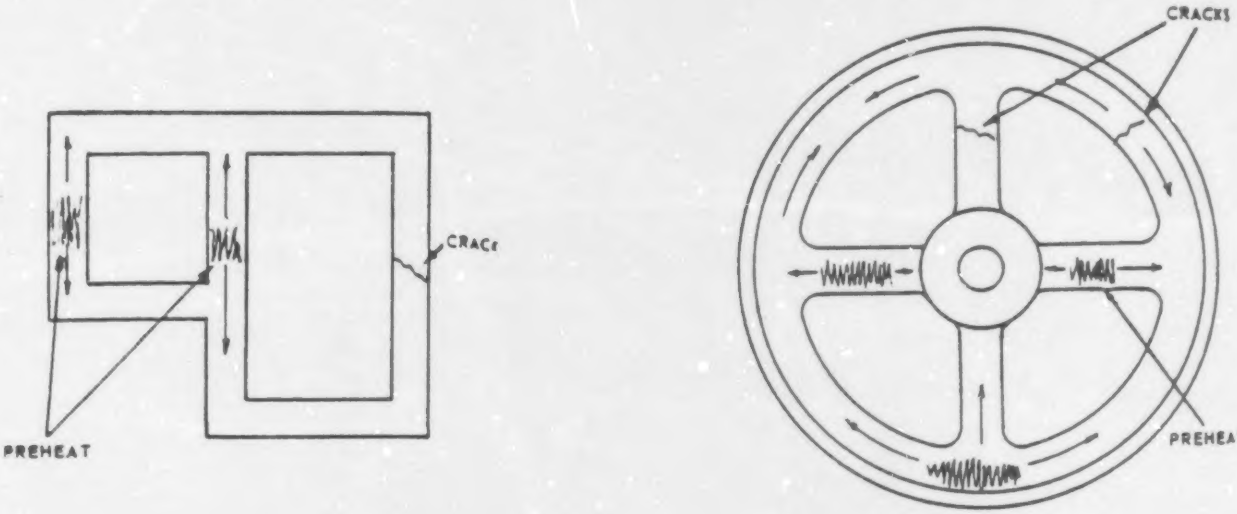


Fig. 18-13. Local preheating of structural cast iron bodies.

Castings that are too large for preheating with equipment available or castings welded in place on the machine must be welded "cold". Even so, however, any amount of heat in the casting is helpful while welding. To weld at room temperature is better than when it is freezing, and 200 degrees is better than 100 degrees.

When welding a casting "cold", it is necessary to run a short bead about 1 inch long and then allow it to cool until you can lay your hand on it before depositing the next bead. The backstep method of welding, illustrated on the transparency provided, is used for cold welds on cast iron. It is also advisable to peen or hammer the weld deposit while it is cooling to help the metal stretch rather than crack as it contracts. Cold welding may seem slow but this is the only feasible method of repairing heavy castings, such as motor blocks, and machine bases in the small shop. Cold welding can only be done by the metallic-arc process because of the concentrated heat and instantaneous molten puddle produced. Never weave if cold welding is used.

Proper joint preparation of a break in cast iron is important in obtaining a strong weld. When the casting is broken in two or more pices, form a vee by grinding the broken edges. Be sure to leave 1/16" to 1/8" at the center to help in aligning the pieces. If the casting is only cracked, determine how long the crack is ans whether it has any branches. To do this, clean the surface and paint with kerosene. After several minutes wipe off the kerosene and rub a piece of white chalk over the cracked area. Cracks will show up as dark wet lines in the chalk. Center punch and drill a 1/8" hole slightly beyond the end of each crack. This will stop the crack from going farther when you weld it and will also show how thick the casting is at the point. Vee out all cracks 1/8" to 3/16" deep with a grinder or diamond-point cold chisel. If the casting thickness is under 3/16", vee out half the thickness.

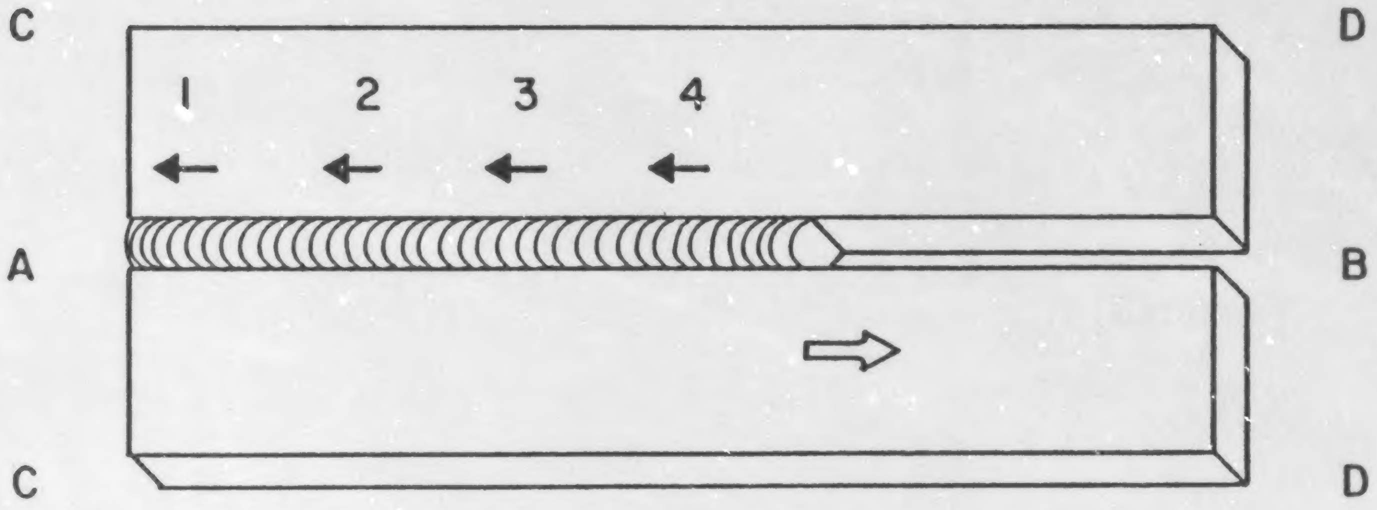
When it is necessary to obtain a weld that is liquid-tight, the possibility of leaks may be eliminated by the use of sulfur. Apply stick sulfur, which can be obtained at a drug store, to the welded joint while it is still warm. The sulfur will melt and seal any cracks or pinholes. Do not apply sulfur until all welding has been completed, as severe porosity will result from attempting to weld over sulfur.

When welding cast iron to steel, use the nickel electrode. Follow these recommendations for cast-iron welding:

1. Clean castings to remove dirt, oil, and grease.
2. Grind or burn a groove in all but very thin castings.
3. Select electrode with ENi (machine designation) if you wish to file or machine the weld. Select electrode with E St (nonmachinable designation), if no finishing is to be done.
4. Select a lower current setting for welding cast iron.
5. Preheat all parts before welding if at all possible.
6. Make all welds Back step technique (TM) if possible.
7. Run short passes and allow to cool before making next pass.
8. Peen beads lightly to relieve stresses and prevent cracking.
9. Allow casting to cool slowly.

USE BACK STEPPING TECHNIQUE

AgIII-IX-32



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Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana-Champaign (Arc Welding 77)

Summary of cast iron welding procedures.

Cast-iron type	Procedure	Treatment	Properties
Gray iron	Weld with cast iron	Preheat and cool slowly	Same as original
Gray iron	Braze weld	Preheat and cool slowly	Weld better; heat-affected zone as good as original
Gray iron	Braze weld	No preheat	Weld better; base metal hardened
Gray iron	Weld with steel	Preheat if at all possible	Weld better; base metal may be too hard to machine; if not preheated, needs to be welded intermittently to avoid cracking
Gray iron	Weld with steel around studs in joint	No preheat	Joint as strong as original
Gray iron	Weld with nickel	Preheat preferred	Joint as strong as original; thin hardened zone; machinable
Malleable iron	Weld with cast iron	Preheat, and postheat to repeat malleableizing treatment	Good weld, but slow and costly
Malleable iron	Weld with bronze	Preheat	As strong, but heat-affected zone not as ductile as original
White cast iron	Welding not recommended		
Nodular iron	Weld with nickel	Preheat preferred; postheat preferred	Joint strong and ductile, but some loss of original properties; machinable; all qualities lower in absence of preheat and/or postheat

The James F. Lincoln Arc Welding Foundation

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Welding Aluminum:

While aluminum is one of the newest metals developed for commercial use, going back only about 50 years, it has become important to industry. It is light-weight (about one-third as heavy as steel) and yet it has a high strength-to-weight ratio. It is a good conductor of electricity and has resistance to corrosion.

Aluminum can be welded by gas welding and many other welding processes. It is comparatively easy to fabricate. Much of the aluminum used in industry is welded with the shielded metal-arc and the gas metal-arc and gas tungsten-arc processes. It is highly desirable, however, for the welding student to practice welding aluminum with the oxyacetylene process so that they can better judge the flow of metal and heat ranges.

Characteristics of Aluminum

The three categories of aluminum which have the most welded applications are commercially pure aluminum, wrought aluminum alloys, and aluminum casting alloys.

Pure aluminum melts at 1,220 degrees F., while weldable commercial aluminum alloys have a melting range of 900 degrees to 1,220 degrees F. Compare these temperatures with steel which melts at about 2,800 degrees F., and copper, which melts at about 1,980 degrees F. See temperature data chart provided to compare melting points of various metals. Aluminum does not change color during heating, and when the melting temperature is reached, it collapses suddenly. This characteristic is called hot-shortness. Because aluminum is hot-short, it requires support when hot.

Aluminum is a good thermal conductor. It conducts heat about three times faster than iron and requires higher heat input than that used in welding steel.

Aluminum expands during heating. For this reason aluminum welds have a tendency to crack because of the shrinkage that takes place in the weld metal when cooling. To much restraint of the parts during cooling may also result in weld cracking. The speed of welding is also important. Welding at a slow rate of speed causes more heat input into the part being welded. This increases the rate of expansion and contraction.

Filler Rod

The selection of the proper filler rod for aluminum welding depends on the composition of the base metal. The AWS-ASTM classification R!!)) is recommended for welding commercially pure aluminum sheet (1100); and R1260 and R4043, for other types of aluminum. Castings are welded with R-C4A, R-CN42A, R-SC51A, R-SG70A, and R-2G61A.

Aluminum filler rods are obtainable in sizes of 1/16, 3/32, 1/8, 5/32, 3/16, and 1/4 inch in diameter. Standard lengths are 36 inches.

As a rule, the diameter of the filler rod should be equal the thickness of the metal being welded. A rod that is too large melts too slowly. Thus it retards the fluid action of the weld pool and may cause a lack of fusion. On the other hand, a rod that is too small melts too fast and may be burned. There is also not enough filler metal for the weld pool. This overheats the weld and may cause burn-through.

Flux

The welding of aluminum requires the use of flux to remove the aluminum oxides that are on the surface and those that are formed during welding. The flux-oxide compound forms a slag which is expelled from the weld pool by the action of the flame and the molten metal.

A number of commercial fluxes are available. Those in powdered form, which are mixed with alcohol or water to make a paste, are the most practical. Mixing should be done in a glass or ceramic container or an aluminum or stainless steel container. Containers of steel, copper, or brass may contaminate the flux and should not be used.

When welding sheet aluminum, a brush is normally used to spread the flux on the welding area and to coat the welding rod. When welding cast aluminum, the flux is applied to the end of the filler rod by dipping its heated tip into the flux. During welding the flux melts and forms a protective coating over the molten metal and the heated end of the filler rod. The flux is meldted in advance of the weld puddle and thus cleans the base metal before it is welded. The flux that is applied to the base metal should be heated slowly before welding to insure that excess moisture is driven off. This is done to prevent spattering and porosity.

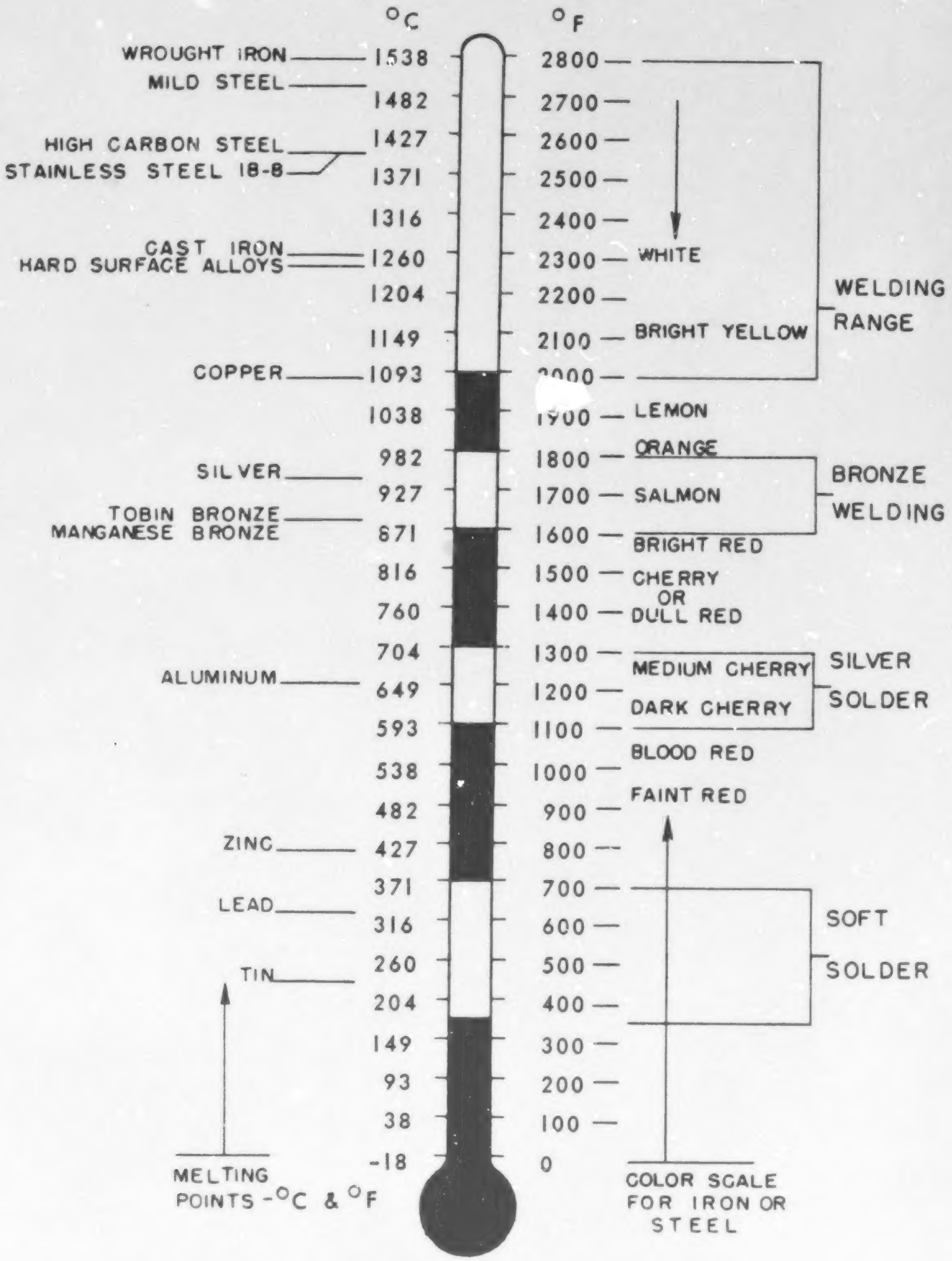
Some welders prefer filler rods that are prefluxed or flux-covered electrodes of the type used for the shielded metal-arc welding of aluminum. When such electrodes are used, it is not always necessary to apply flux to the base metal. Better results are generally obtained, however, if flux is applied to the work. The period betwee fluxing and welding should not exceed 45 minutes.

Flame Adjustment

Acetylene is the most popular gas to use with oxygen for welding aluminum because of its high heat and wide availability. Hydrogen is also used with oxygen for the welding of aluminum. Because of its lower heat, it is used chiefly in the welding of the thinnest guages of aluminum sheet.

In order to produce clean, sound welds, and maximum welding speed, a neutral flame is ideal and a slightly reducing flame

TEMPERATURE DATA


°C
°F
WROUGHT IRON — 1538 — 2800
MILD STEEL
1482 — 2700
HIGH CARBON STEEL — 1427 — 2600
STAINLESS STEEL 18-8 — 1371 — 2500
1316 — 2400
CAST IRON
HARD SURFACE ALLOYS — 1260 — 2300
WHITE
1204 — 2200
1149 — 2100
BRIGHT YELLOW
WELDING RANGE
COPPER — 1093 — 2000
1038 — 1900
LEMON
982 — 1800
ORANGE
SILVER
927 — 1700
SALMON
BRONZE WELDING
TOBIN BRONZE
MANGANESE BRONZE
871 — 1600
BRIGHT RED
816 — 1500
CHERRY OR DULL RED
760 — 1400
704 — 1300
MEDIUM CHERRY
SILVER SOLDER
ALUMINUM — 649 — 1200
DARK CHERRY
593 — 1100
BLOOD RED
538 — 1000
FAINT RED
482 — 900
ZINC — 427 — 800
371 — 700
LEAD — 316 — 600
SOFT SOLDER
260 — 500
TIN
204 — 400
149 — 300
93 — 200
38 — 100
-18 — 0
MELTING POINTS - °C & °F
COLOR SCALE FOR IRON OR STEEL

(carburizing) is highly satisfactory. You will recall that aluminum oxidizes readily. The reason for the excess acetylene flame is to make sure that the gas mixture does not stray to the excess oxygen side. An oxidizing flame causes a bead that balls up. The weld has poor fusion, poor penetration, and more porosity.

Aluminum may also be welded with the oxyhydrogen flame. The same torch and type of tip are used. Because of the lower temperature of the oxyhydrogen flame, a larger tip size is required. You may have some difficulty adjusting the flame. It is very similar, however, to the adjustment of the oxyacetylene flame, Fig 18-7.

The neutral oxyhydrogen flame is a white to pale violet color, fairly large, and rather indistinct. The small, well defined cone in the center has a bluish tinge.

The oxidizing flame has a very short, blue inner cone. The flame is thinner than the reducing flame and ranges in color from white to transparent. Because these differences are very hard to see, a flowmeter may be the best means for assuring the desired hydrogen-oxygen ratio.

A soft flame is essential in all oxy-gas welding of aluminum. A strong or noisy flame causes turbulence and lowers weld quality. The proper pressure adjustment at the regulators and precise torch adjustment are a must.

Aluminum Welding Technique

EDGE PREPARATION. As with all other metals, the type of edge preparation depends upon the thickness of the metal being welded. On aluminum butt joints up to a thickness of 1/16 inch to 5/32 inch can be welded in the form of a square butt joint, but the plate edges should be notched. For aluminum plate 3/16 to 7/16 inch thick, the edge preparation is that for a single-bevel butt joint with a 90-degree V. For thicknesses of 1/2 inch and over, the double-bevel butt joint with a 90-degree V on each side is used if both sides are accessible. Table 18-2 lists the rod and tip sizes and gas pressures for welding various thicknesses of aluminum.

CLEANING. Since grease, oil, and dirt cause weld porosity and interfere with welding, they should be removed from the welding surfaces. Commercial degreasing agents are available for this purpose. Wire brushing may also be used to remove heavy oxide films from the plate surfaces. Removal of oxides permits more efective fluxing action.

PREHEATING. Like cast iron, cast aluminum requires careful preheating before welding and slow cooling after the weld is completed. Preheating is always recommended for gas welding aluminum when the mass of the base metal is such that heat is conducted away from the joint area faster than it can be supplied to produce fusion. A large difference in temperature between the surrounding metal and the weld area increases welding difficulties. The preheat temperature must stay below

700 degrees F. Preheat temperature-indicating compounds can be used to advantage. These are available in both crayon and liquid form. They are accurate and are made in almost any temperature range.

JIGS AND FIXTURES. Aluminum and many of its alloys are weak when hot. Aluminum parts, especially thin stock, should be supported adequately. Jigs and fixtures maintain alignment and reduce buckling and distortion. It is especially important for the edges of the joint to be spaced and aligned correctly. Tack welding before final welding also aids in maintaining alignment and minimizing distortion. Tack welds should be placed carefully. They must have good penetration and fusion.

WELDING POSITIONS. Aluminum welding can be done in all positions. Overhead welding however, is difficult and should be attempted on the job only by highly experienced welders. The flat position is preferable and should be used whenever possible.

Horizontal welding technique is similar to that for flat welding. Special manipulation of the rod and torch is necessary, however, to offset tendency of the molten metal to sag and build up the lower edge of the weld bead. Butt joints are not practical in the horizontal position.

Vertical welding is usually preformed on materials 1/4 inch or thicker. It is almost impossible to keep thinner materials from burning through, and the weld pool becomes too fluid and spills over. Torch and welding rod angles are about the same as for all other vertical welding.

POSTWELD CLEANING. Through cleaning after welding aluminum is very important. Flux residues on gas-welded sections corrode aluminum if moisture is present. Small sections may be cleaned by a 10 to 15-minute immersion in a cold 10 percent sulfuric acid bath, or a 5 to 10-minute immersion in a cold 5 percent sulfuric acid bath held at 150 degrees F. Acid cleaning also may be used to remove flux residue, particularly on parts that are too large to be immersed. Brushing may also be necessary to remove adhering flux particles.

Sheet Aluminum Welding Practice: Jobs 18-J58, J59, and J60.

1. Prepare, clean and tack the joint. It is recommended that you practice on aluminum sheet ranging from 14 guage to about 3/16 inch thick. Select the proper tip size for the thickness of the metal being welded. Select the filler rod according to the type of aluminum being welded.

2. Apply flux to the filler rod and the work.

3. The welding technique used to weld aluminum is not much different than that used in the welding of steel. Remember that aluminum does not change color when heated,

it burns through readily, it forms oxides rapidly, and it has a high rate of expansion and contraction. Start welding about 1 1/2 inches in from the edge of the sheet and travel to the opposite edge. Heat the entire plate or joint evenly.

4. After a small pool has been formed, point the flame in the direction of welding at an angle of about 30 degrees, Fig. 19-8. This position heats the plate ahead of you, reduces the problem of burning through, and increases the welding speed. Do not let the cone of the flame touch the weld pool.

A distance of 1/8 to 1/4 inch is advised. Make sure the weld pool is in a molten state before adding filler rod. Stir the filler rod in the weld pool. This action caused the oxides to rise to the surface of the weld of the plate and the size of the weld bead desired. Side-to-side movement should not be used for thin sheets. On heavier sheets the amount of movement depends upon the size of the weld bead desired.

As the end of the joint is approached, flatten out the angle of the torch until the flame is reaching mainly ther welding rod. This is particularly recommended for the thinner guages of aluminum.

5. Return to the beginning of the short weld and restart the weld. Weld towards the other edge of the plate.

6. Clean the weld and base metal by brushing with hot water.

7. Continue to practice these welds on various thicknesses of aluminum until you can make welds of satisfactory appearance to your instructor. Note the weld characteristics shown in Fig. 18-9. Be particularly concerned about fusion along the edges of the weld, a smooth surface without pits, holes and depressions, and good penetration on the back side. The beads should not be too wide, and their edges should be parallel.

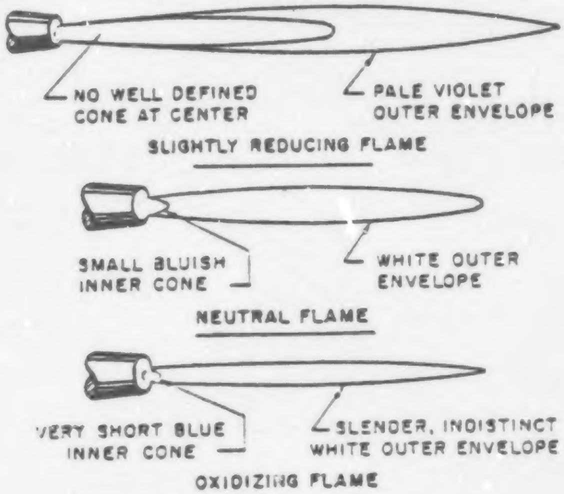
Table 18-2

Rod sizes, tip sizes, and gas pressures for the welding of aluminum.

Aluminum thickness (inch)	Filler rod diameter (inch)	Oxyacetylene welding: Orifice diameter in tip of torch (inch)	Oxyacetylene welding: Oxygen pressure (p.s.i.)	Oxyacetylene welding: Acetylene pressure (p.s.i.)	Oxyhydrogen welding: Orifice diameter in tip of torch (inch)	Oxyhydrogen welding: Oxygen pressure (p.s.i.)	Oxyhydrogen welding: Hydrogen pressure (p.s.i.)
0.020	3/32	0.025	1	1	0.035	1	1
0.032	3/32	0.035	1	1	0.045	1	1
0.050	3/32	0.045	2	2	0.065	2	1
0.064	3/32	0.045	2	2	0.065	2	1
0.080	1/8	0.055	3	3	0.075	2	1
1/8	1/8	0.065	4	4	0.095	3	2
3/16	5/32	0.065	5	5	0.095	3	2
1/4	3/16	0.075	5	4	0.105	4	2
5/16	3/16	0.085	5	5	0.115	4	2
3/8	3/16	0.095	6	6	0.125	5	3
1/2	1/4	0.100	7	7	0.140	8	6
5/8	1/4	0.105	7	7	0.150	8	6

Kaiser Aluminum & Chemical Corp.

18-7. A neutral flame (center) tending toward a slightly reducing flame (top) is recommended for the oxyhydrogen welding of aluminum.


NO WELL DEFINED CONE AT CENTER
PALE VIOLET OUTER ENVELOPE
SLIGHTLY REDUCING FLAME
SMALL BLUISH INNER CONE
WHITE OUTER ENVELOPE
NEUTRAL FLAME
VERY SHORT BLUE INNER CONE
SLENDER, INDISTINCT WHITE OUTER ENVELOPE
OXIDIZING FLAME

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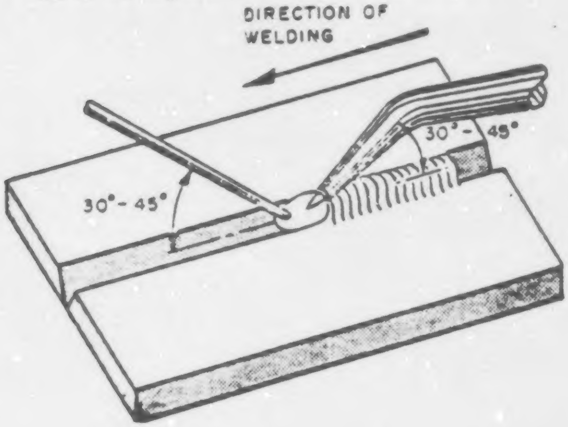
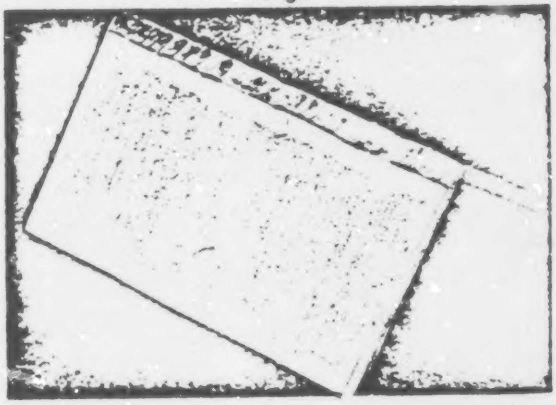
18-8. Typical angles for torch and filler rod range from 30 to 45 degrees in the welding of aluminum.


DIRECTION OF
WELDING
30° - 45°
30° - 45°

18-9. A corner weld in aluminum sheet. The ripples should be smooth, and the weld should show no overhang.



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Stainless Steel

-Gas-

Because of its strength, durability, high temperature service, and resistance to corrosion, stainless steel is used in ever-increasing quantities. The common terms for the popular types are 18-8, 25-12, and 25-20. In each of these the first figure refers to the percentage of chromium and the second figure, to the percentage of nickel. Almost without exception the commercial types of stainless can be welded with the oxyacetylene process, but most of this welding is being done with the shielded metal-arc and the gas metal-arc and gas tungsten-arc processes. Oxyacetylene welding of stainless steel is still used for light guage sheets. The following factors must be considered in the welding of stainless with the oxyacetylene process.

1. Joint desing and preparation are like those used for steel. Thicknesses above 1/8 inch must be beveled.

2. For welding the high-chromium steels, the welding tip should be one or two sizes smaller than that used for the same thickness of carbon steel because as the content of chromium increases, the heat conductivity decreases.

3. A flux is necessary because the chromium in stainless steel oxidizes rapidly and acts as a barrier between the flame and the surface of the material being welded. Most fluxes are powder which must be mixed to a paste in a nonmetallic container. The flux is painted on the filler rod and both sides of the joint being welded.

4. Some chromium is lost as a result of oxidation during welding. This loss is restored to the weld by the use of a filler rod which contains at least 1 to 1 1/2 percent more chromium than the base metal.

5. Group 1, martensitic steels (400 and 500 series, straight chromium steels, 12 to 18 percent chromium, basic type 410), which have the characteristic of air hardening, should be preheated locally or completely to 300 to 500 degrees F. This prevents excessive air hardening and possible cracking. Parts should also be annealed. R308, R309, or R310 filler wire is used for welding.

6. Group 2, ferritic steels (400 series, straight high chromium steels 15 to 27 percent chromium, no nickel, basic type 430), which are not hardenable, should be preheated to 300 to 500 degrees F., especially in cold weather. Parts should also be annealed. Filler wire R308, R309, or R310 is used for welding.

7. Group 3, austenitic chromium-nickel steels (200 and 300 series, which includes the basic type 18-8 [types 302 and 304], 18-percent chromium and 8 percent nickel), should be heat treated if the part is to be put into severe

general uses, heat treatment is not necessary. Filler wire R308 is used for welding.

8. A precise neutral flame must be used. Since chromium oxidizes so readily, the oxidizing flame would burn out increased amounts of chromium and reduce the resistance to corrosion. An excess acetylene flame introduces an amount of carbon in the weld metal which reduces its quality. Check the flame frequently to make sure that it does not get into the oxidizing range. Some welders prefer a very slight acetylene feather to make sure that the flame does not become oxidizing.

9. The welding technique is like that used for steel. The flame should not touch the weld metal, and it should be held at a steeper angle than that for steel. When adding filler rod, hold it close to the flame. When rod is not needed, it should be withdrawn from the flame. Be careful not to overheat the filler rod or the weld pool. Avoid going back over a weld since this increases the amount of heat used and thus reduces corrosion resistance. Use 18-8 columbium-bearing filler rods.

10. Depending upon the final use, it may be necessary to grind the weld smooth and polish it to match the base metal. If a polish is not needed, you may have to remove scale by sandblasting or by pickling with acid.

STAINLESS STEEL ARC WELDING

It is easier to arc weld stainless steel than to gas weld it. All arc welding methods such as manual arc welding, automatic arc welding, atomic-hydrogen arc welding, and inert gas arc welding may be easily and effectively used in welding this type of steel. The consumable electrode must match the type of stainless steel being welded. To obtain good, consistent results, the operator must carefully follow recommendations made by both the stainless steel manufacturer and the electrode manufacturer.

The American Welding Society has prepared identification numbers for a variety of stainless steel welding electrodes. For example, E 308-15 is for AISI 301 to 308 series, and is used in all positions as indicated by the number 1 in the AWS designation, EXXX-IX, and has a lime coating as indicated by the number 5 in the AWS designation EXXX-X5 which calls for DC reversed polarity. Because there are at least seven main classifications for the austenitic steels, great care should be used when selecting the electrode to be used. The current settings are slightly lower, but the electrode sizes are very similar to the choices for mild steel welding. DC reversed or AC current is used. AWS XXX-15 electrode are used with DC reversed polarity or AC. The electrodes must be kept dry and clean. The electode coating must be free from cracks and chips. The welding procedure is almost identical with mild steel practice. The same electrode position, crater appearance, electrode motion or weave should be used. It is advantageous to use as short an arc as possible.

Gas tungsten-arc welding is particularly desirable with stainless steel. Strong, good looking welds may be obtained with a minimum of discoloration and warpage. The metal behaves normally under the arc. Both the gas tungsten-arc and the gas metal-arc processes are suitable. When using the gas tungsten-arc method, the welding rod is added in a manner similar to gas welding.

Since the use of flux is not necessary with inert gas arc welding, no after cleaning is necessary.

HARDSURFACING

Three types of hardsurfacing materials are of special interest to the farmer-owner of arc welding equipment. They are a high abrasion resistant material available in powder or electrode form, a high impact resistant work-hardening alloy available in electrode powder form, high-carbon steel electrode (Fig. 91).

The high abrasion resistant hardsurfacing powder is used for thin cutting edges that slide through the soil, such as plowshares, cultivator sweeps, etc. When sharp cutting edges are required, the hardsurfacing should be applied to one side only. The softer metal will thus wear away, keeping a sharp edge of wear-resistant hardsurfacing materials exposed.

Prepare the area to be hardsurfaced by grinding it bright. Apply dry powder as it comes from the can or mix it with water to form a paste. With either one, apply a layer as wide as desired for the finished deposit and about twice as thick. Then, heat the powder to fuse it to the base metal with a carbon arc torch. Move the torch in a circular path, staying slightly back from the thin edge to avoid burning it. The finished job should look like Fig. 82.

Using high abrasion resistant hardsurfacing material in electrode form for thicker edges that slide through the soil, such as grader blades. Apply weaving beads, using a relatively long arc and just enough amperage to fuse the beads together. Avoid excessive penetration which will mix the hardsurfacing material with the base metal. Results are similar to those obtaining using the powder and the carbon-arc torch but the job can be done faster on thick pieces where burn-through is no problem.

Parts subject to impact, or pounding, and those which wear from metal-to-metal contact may be hardsurfaced with a high impact resistant, work-hardening powder or electrode. The deposit from this electrode is tough and relatively soft when first applied. However, as the surface is exposed to wear, it work-hardens or becomes harder. Apply weaving beads at low amperage to secure fusion but not excessive penetration.

New surfaces may be built on tools, such as hammers, shears, cutters, and chisels, with a high-carbon steel or tool-steel electrode. Apply overlapping beads to the edge with a weaving motion. The deposit can be forged and heat treated. Tools like cold chisels can be made by forging out a piece of ordinary mild steel, and applying a hard edge with a high-carbon steel electrode. It is best to run two or more passes, as the first pass will be diluted somewhat with mild steel. After the deposit has cooled, grind it to form a cutting edge. Heat treating may or may not be necessary, depending on the hardness secured in the original application. Chipped hammer faces may be restored by applying weaving beads of high-carbon steel hard-surfacing electrodes. After cooling, these faces may be ground to the original size and shape.

Properties of various hardsurfacing materials are identified on the chart below:

Properties of hard-surfacing electrodes.

Abrasion	Friction	Impact	Hardness	Ductility	Machinability	Corrosion	Hard-surfacing guide
1	2	5	1	6	6	1	Carbide type—powder form
1	1	5	1	5	6	1	Carbide type—high abrasion resistance
3	2	5	1	5	6	2	Carbide type—good abrasion, moderate toughness
4	3	4	1	5	5 *4	5	Semi-austenitic type—high carbon, chromium alloy
5	4	1	6	2	4	6	Austenitic type—11 to 14% manganese
5	5	1	6	1	4	1	Austenitic type—18-8 and 25-20 stainless
5	2	5	1	6	6 *4	4	Martensitic type—high speed tool steel
2	2	5	1	6	6 *4	4	Martensitic type—5% chrome tool steel
5	4	3	2	4	5 *3	5	Martensitic type—low carbon chrome, Manganese
5	5	3	3	4	4 *3	5	Martensitic type—medium carbon, chrome, manganese
6	6	2	6	3	3 *1	6	Ferritic type—low carbon with 5% molybdenum
6	6	1	6	1	1	6	Ferritic type—conventional low carbon electrode

Scale 1 to 6
1. Excellent
2. Very good
3. Good
4. Fair
5. Poor
6. Very poor
*Annealed condition

Tillage and Planting Equipment

Instructor's Guide:

1. This unit is designed to acquaint students with the function, nomenclature, and operation of basic tillage implements and the identification of other types of tillage equipment.

2. The basic implements for this unit are the moldboard plow, disc harrow, tooth type harrow and field cultivator.

3. A variety of other implements will be utilized, to a lesser degree, for purposes of identification and terminology.

4. "Live models" of the basic implements should be available for the students to practice maintenance, adjustments and hitching.

5. This unit should be scheduled at a time of the year when it is possible to operate implements under actual field conditions.

6. Students should receive "hands on" experience in operating basic tillage implements.

7. This unit is based on Fundamentals of Machine Operation (Tillage) by John Deere and Co. Copyright provisions will not permit the material to be included as part of the unit. However, the student activities are referenced to chapters in F.M.O.

   The F.M.O. unit may be obtained from:

   John Deere Service Publications
   Department F
   John Deere Road
   Moline, Illinois 61265

   Single copies of the F.M.O. manuals are $13.15. Ten or more copies can be obtained for $10.52. Instructor's Kit is $25.75 per copy.

8. If local farmers utilize a different set of basic tillage equipment than those in this unit, modify the F.M.O. reading assignments to be compatible with local farming methods.

9. Scale models and cut-away models of farm implements are sometimes available through local implement dealers. These models are very helpful in classroom instruction of farm implements.

Objectives:

Upon completion of this unit, the student will be able to:

1. Describe the effects of plowing land.
2. Identify the parts of a moldboard plow bottom.
3. Identify the six main types of plowbottoms - by shape.
4. Describe the purpose of the moldboard, landslide and share.
5. Identify four basic types of plow standards.
6. Describe the purpose of a coulters, trashboards and jointers.
7. Describe purpose of root cutter, weedhooks, gauge wheels, and moldboard extension when used as attachments to the moldboard plow.
8. Idenfity three basic types of plow frams.
9. Describe integral, semi-integral, drawn and reversible type plows.
10. Understand the three principles of plow hitching - center of load, center of pull, and line of draft.
11. Adjust vertical hitch.
12. Level a plow.
13. Adjust width of cub.
14. Adjust coulter.
15. Adjust trash board.
16. Adjust jointer.
17. Adjust gauge wheel.
18. Prepare a plow for field operation.
19. Provide maintenance service on a plow.
20. Prepare a plow for storage.
21. Lay out a headland for plowing.
22. Operate a tractor drawn plow in a field operation.

DISC HARROWS

23. Define secondary tillage.

24. Identify the two classes of disc harrows.

25. Identify four primary types of disc harrows.

26. Identify the major parts of a disc harrow.

27. Adjust a disc harrow for efficient field work.

28. Properly maintain a disc harrow.

29. Hitch and unhitch a harrow.

30. Operate a disc harrow in the field.

TOOTH TYPE HARROW

31. Identify three main frame styles of harrows.

32. Distinguish between a spring tooth harrow, field conditioners, flexible tine cultivators and spike tooth harrows.

33. Inspect a harrow for maintenance needs.

FIELD CULTIVATORS

34. Identify common types of field cultivators.

35. Distinguish between shanks, points, sweeps, and wings of a field cultivator.

36. Hitch and unhitch a field cultivator.

OTHER TILLAGE EQUIPMENT

37. Identify tillage equipment such as:

    --Disc plows
    --Chisel plows
    --Stubble mulch plows
    --Disc tillers
    --Stubble mulch tillers
    --Rotary tillers
    --Listers and bedders
    --Subsoilers
    --Roller harrows and packers
    --Rod weeders
    --Rotary hoes

Teaching Aids:

1. Copies of F.M.O. Tillage equipment from John Deere and Company.
2. Live models of a moldboard plow, disc harrow, tooth type harrow, field cultivator, and other tillage equipment that is readily available.
3. Cut-away and scale models of tillage equipment.
4. Transparencies of basic equipment showing nomenclature.
5. Field laboratory for practice in the operation of tillage equipment.
6. Farm implement dealers in nearby locations.

Student Activities:

1. Read the objectives for the unit.
2. Read Chapter 5 (Moldboard Plows) in Fundamentals of Machine Operation.
3. Perform adjustments on a "live model" plow.
4. Take a quiz on moldboard plow.
5. Read Chapter 14 (Disc Harrows) in Fundamentals of Machine Operation.
6. Perform adjustments and hitching of disc harrow.
7. Take a quiz on disc harrows.
8. Read Chapter 16 (Tooth Type Harrows) in Fundamentals of Machine Operation.
9. Study the nomenclature of a harrow (live model).
10. Take a quiz on tooth type harrows.
11. Read Chapter 17 (Field Cultivators) in Fundamentals of Machine Operation.
12. Practice hitching and unhitching of a field cultivator (live model).
13. Take a quiz on field cultivators.
14. Go on a field trip to a farm implement dealer and identify other types of tillage equipment such as disc plows, chisel plows, tillers, listers, bedders, subsoilers, etc.
15. Take a unit exam on tillage equipment.
16. Operate a tractor and moldboard plow.
17. Operate a tractor and disc harrow.
18. Operate a tractor and tooth type harrow.

References:

1. Fundamentals of Machine Operation, Tillage. John Deere & Company, Moline, Illinois. (Refer to updated Hobar Publications Catalog)

MEATS

Instructor's Guide:

1. The following unit is a written outline utilizing the following as references: a) Live Animal Carcass Evaluation and Selection Manual and b) Meat Evaluation Handbook. It is recommended that these resources be used as the textbooks for this unit.
2. Read the objectives and the materials included in this unit.
3. Locate resource material from the following:

   OSU Extension Service
   OSU Dept. of Animal Science
   OSU Bookstore
4. Locate field trip possibilities for live animal evaluation.
5. Locate field trip possibilities such as meat lockers, packing plants, and/or mobile slaughter units for wholesale, retail, yield and quality grading evaluation.
6. Utilize slides of meat cuts to be used for classroom instruction.

Objectives:

Upon completion of this unit, the student will be able to:

1. Understand the common terms used in the livestock and meat industry.
2. Review the parts of beef, sheep and swine.
3. Identify what to look for in live animal evaluation.
4. Identify wholesale and retail cuts of beef, sheep and swine.
5. Explain marbling in meat quality.
6. Understand the factors of determining quality grades.
7. Properly quality grade meat carcasses.
8. Understand the factors of determining yield grades.
9. Properly yield grade meat carcasses.
10. Understand the mathematical equations to determine the yield grades of beef and lamb carcasses.

Teaching Aids:

1. Slides of the retail cuts of beef, sheep and swine.
2. "Live Animal Carcass Evaluation and Selection Manual." Boggs and Merkel.
3. "Meat Evaluation Handbook." National Livestock and Meat Board.
4. Local beef, sheep or swine producers for live animal evaluation.
5. Local meat lockers, packing plants or mobile slaughter units for wholesale and retail evaluation.

Student Activities:

1. Read the objectives of the unit.
2. Review the terms used in the meat industry.
3. Review live animal evaluations.
4. Review wholesale and retail cuts of meat.
5. Yield and quality grade carcasses.
6. Participate in field trips.
7. Organize all material in meats section in Ag notebook.

References:

1. "Live Animal Carcass Evaluation and Selection Manual," Boggs and Merkel: OSU Bookstore.
2. "Meat Evaluation Handbook," National Livestock and Meat Board: OSU Bookstore.
3. "The Oregon Carcass of Merit Program," Extension Bulletin #831. OSU Extension Service.
4. "2x2 Color Slide Sets": Information material a) Live Animal Evaluation, b) Carcass Evaluation, c) Quality Grading and d) Identification of Retail Cuts. Available from:

   Vocational Instructional Services Instructional Materials
   Texas A & M University
   F.E. Box 182
   College Station, Texas 77843-2588 Phone: (713) 845-6601

5. Wall Charts for Retail Cuts of Beef, Sheep and Swine.
Available from: National Livestock and Meat Board
444 North Michigan Avenue
Chicago, Illinois 60611

Appendices:

1. Appendix A: External Parts of Swine
2. Appendix B: External Parts of a Steer
3. Appendix C: External Parts of Sheep
4. Appendix D: Wholesale Cuts of Pork
5. Appendix E: Wholesale Cuts of Beef
6. Appendix F: Wholesale Cuts of Lamb
7. Appendix G: Illustrations of Marbling
8. Appendix H: A Short Cut Method for Yield Grading Beef Carcasses
9. Appendix I: Yield Grading Table for Lamb Carcasses
10. Appendix J: Marbling, Maturity and Beef Quality Grade Chart
11. Appendix K: Pork Carcass Grading Chart
12. Appendix L: Lamb Carcass Grade and Maturity Chart

Common Terms:

1. Physiological age: the stage of development of an animal.

2. Growth: an increase in the structural tissues; that is, bone, muscle and the connective tissues associated with muscle.

3. Muscle: evaluated in live cattle, hogs and sheep by assessing the muscling primarily in the round, ham and leg.

4. Marbling: the intermuscular fat.

5. Finish: the amount of fat covering over the carcass or wholesale cut as well as to the fat in the body cavity.

6. Conformation: in grading meat refers to the proportionate development of the various parts of the carcass or wholesale cut and to the ratio of meat to bone.

7. Ossification: the process of bone formation. As animals age, bones form and become hard, flinty and flattened.

8. Feathering: the streaks of fat in evidence within the muscles between the ribs. Used primarily in lamb carcass judging.

9. Cutability: the proportion of the carcass that is salable as trimmed retail cuts.

10. Dressing percentage: the chilled carcass weight divided by the live weight times 100. The higher the percentage the more profit to be made.

11. Quality: quality includes maturity, marbling, texture of lean, firmness of the lean and fat and the color of the lean and fat.

12. Quality grade: measured primarily in terms of marbling and firmness of lean in relation to maturity.

13. Yield grade: determined by considering four characteristics:
    a) amount of external fat
    b) amount of kidney, pelvic and heart fat
    c) area of rib-eye muscle
    d) carcass weight.

I. Meats

- A. The parts of beef, sheep and swine (Refer to Appendices A, B, and C)
- B. Live animal evaluation (refer to Live Animal Carcass Evaluation pages 23-37)
  - 1. Hogs
    - a. Live market hog evaluation essentially an estimation of important carcass characteristics
    - b. These characteristics are those that provide an indication of amount of fat and/or muscle which in turn determines carcass value
    - c. Weight
      - 1) Live weight is the actual weight of the hog at the time of evaluation or slaughter
      - 2) Carcass weight maybe hot or chilled
        - a) Both are used in the industry
        - b) Hot carcass weight can be calculated by multiplying chilled carcass weight by 102%
        - c) Chilled carcass weight needed, then multiply hot carcass weight by 98%
    - d. Dressing percentage
      - 1) Definition: (Chilled carcass weight ÷ live weight) x 100
      - 2) Two major factors affecting dressing percentage
        - a) Amount of fat
        - b) Amount of fill (stomach and intestinal contents)
      - 3) Fat hogs tend to dress higher than lean hogs
      - 4) Hogs with a large fill dress lower than those with less fill
        - a) Fill has a greater effect on dressing percentage than the degree of fatness
        - b) Gilts tend to have less fat than barrows and therefore have a slightly lower dressing percentage
      - 5) Dressing percentage is a poor indicator of carcass value

e. Backfat thickness

   1) The thickness of fat, including skin, to the dorsal surface of the loin eye muscle
   2) An average of 3 measurements

      a) The first rib (over the front foot)
      b) The last rib (midway between the two)
      c) The last lumbar vertebra (over the hind foot)

   3) Measurement of backfat at the 10th rib is the most accurate measurement of all

      a) Slightly more highly related to lean cut or ham and loin percentage
      b) Used to calculate percentage carcass muscle

f. Length

   1) Length estimation points

      a) Midpoint of the longitudinal axis of the front foot to:
      b) Midpoint of the longitudinal axis of the hind foot

g. Loin eye area

   1) Area of the longissimus muscle
   2) Measured at the 10th rib
   3) Related to total carcass muscling in hogs
   4) Width and depth of loin are used to evaluate the loin size

h. Live hog grading

   1) Grading

      a) US #1
      b) US #2
      c) US #3
      d) US #4
      e) US Utility

   2) Yield differences

      a) Difference in degree of fatness
      b) Difference in degree of muscling
      c) Difference in thickness of muscling in relation to skeletal size

2. Beef (refer to Live Animal Carcass Evaluation pages 69-82)
    - a. Live market cattle evaluation is essentially an estimation of important carcass characteristics
    - b. Specific characteristics are evaluated and in turn provide an indication of a carcass value
    - c. Weight
        - 1) Live weight is the actual weight of the cattle at the time of evaluation or immediately prior to slaughter
        - 2) Carcass weight may be either hot or chilled
            - a) Hot carcass weight is 1½-3% higher than or 102% of the chilled carcass weight
            - b) Hot and chilled carcass weights are actual weights
        - 3) Weight is easily obtained and it is the most commonly used characteristic for determining value
        - 4) Producers use weight to calculate
            - a) Production efficiency
            - b) Live cattle, carcasses and beef cuts are bought and sold on a weight and grade basis
    - d. Dressing percentage
        - 1) Definition: (Chilled carcass weight ÷ live weight) x 100
        - 2) Dressing percentage varies with grade, type and condition of the cattle
        - 3) Factors that have the greatest influence upon dressing percentage are
            - a) Amount of fill (stomach and intestional contents)
            - b) Degree of finish (fatness)
            - c) Weight of the hide
    - e. Fat thickness
        - 1) Definition: depth of fat in tenths of inches over the rib-eye muscle at the 12th rib
        - 2) Consists of a single measurement or estimate
        - 3) Fat thickness at the 12th rib is one factor used to calculate yield grade

f. Rib eye area

  1) Definition: area of the longissimus muscle measured in square inches at the 12th rib
  2) Guideline for estimating rib eye area on live steers

    a) 1.1 in^2/100 lbs. of live weight between 900-1250 lbs.
    b) Over 1251 lbs., the rib eye area will not increase at the rate of 1.1 in^2/100 lbs.

  3) Rib eye area is a fair to good indicator of total carcass muscle
  4) Rib eye area at the 12th rib is one factor used to calculate yield grade and assess muscling

g. Kidney, pelvic and heart fat

  1) Definition: the internal carcass fat associated with the kidney, pelvic cavity and heart expressed as a % of chilled carcass weight (the kidney is included)
  2) The 12th rib fat thickness serves as a guideline for estimated percentage kidney, pelvic and heart fat

h. Marbling

  1) Definition: the intermingling of fat within the muscle
  2) Normally evaluated in the rib eye muscle at the 12th rib
  3) Marbling is usually estimated from amount of external fat on live cattle. The fatter the cattle, the higher the degree of marbling

i. Live cattle grading

  1) Quality grade

    a) US Prime
    b) US Choice
    c) US Good
    d) US Standard
    e) US Utility

  2) Yield grade

    a) 1
    b) 2
    c) 3
    d) 4
    e) 5

3. Lamb (refer to Live Animal Carcass Evaluation pages 121-132)

   a. Live market lamb evaluation is essentially an estimation of important carcass characteristics
   b. Specific characteristics evaluated are amount of fat and/or muscle and quality grade which in turn determines carcass value
   c. Weight

      1) Definition: live weight is the actual weight of lambs at the time of evaluation
      2) Live and carcass weights are actual weights
      3) Hot carcass weight can be calculated by multiplying chilled carcass weight by 102%
      4) Chilled carcass weight can be calculated by multiplying hot carcass weight by 98%

   d. Dressing percentage

      1) Definition: (chilled carcass weight ÷ live weight) x 100
      2) Factors that increase dressing %

         a) Light weight digestive tract and fill
         b) Increased finish
         c) Light weight pelt

   e. Fat thickness

      1) Definition: depth of fat in tenths of inches over the rib eye muscle at the 12th rib
      2) One of the factors used to calculate yield grade

         a) As fat increases (thickness), the yield grade increases in numerical value
         b) Fat thickness is an assessment of external fat on the carcass; as it increases, it lowers retail yield

   f. Rib eye area

      1) Definition: average area, in square inches, of the right and left rib eye muscle
      2) Rib eye area is related to the total carcass lean
      3) Rib eye area is related to the lamb carcass muscling and is widely used as an indicator

g. Kidney and pelvic fat

  1) Definition: the internal carcass fat associated with the kidney and pelvic cavity
  2) Kidney and pelvic fat used to calculate yield grade
  3) A reasonable estimate of %KP may be obtained from the 12th rib fat thickness
  4) It is difficult to determine %KP on live lambs

h. Overall conformation

  1) Quality grade

    a) US Prime$^+$
    b) US Prime$^-$
    c) US Prime^o
    d) US Choice$^+$
    e) US Choice$^-$
    f) US Choice^o
    g) US Good$^+$
    h) Etc.

  2) Refers to the development of muscular and skeletal systems
  3) Best conformation implies a high proportion of edible meat to bone and a high proportion of weight in the demanded cuts

    a) Lambs that are wide and thick in relation to length
    b) Plump, full, well-rounded appearance

i. Leg conformation

  1) Definition: the degree of muscling in the leg expressed in terms of 1/3 of a conformation grade
  2) Used to calculate yield grade
  3) Leg conformation is used as the assessment of muscling
  4) Legs that are thick through the widest part as viewed from the rear and plump and bulging when viewed from the side are high in conformation grades

j. Quality grade

  1) US Prime
  2) US Choice
  3) US Good
  4) US Utility
  5) US Cull

k. Yield grade
    1) Identifies lambs for differences in yield of boneless, closely trimmed, retail cuts from the leg, loin, rack and shoulder
    2) Factors to determine yield grade
        a) Fat thickness at the 12th rib
        b) %KP
        c) Leg conformation

C. Identify the wholesale and retail cuts

1. Beef whole cuts (refer to Appendix D)
    a. Chuck
    b. Rib
    c. Loin
    d. Rump
    e. Round
    f. Shank
    g. Flank
    h. Plate
    i. Foreshank
    j. Brisket

2. Pork wholesale cuts (refer to Appendix E)
    a. Jowl
    b. Boston Butt
    c. Back
    d. Loin
    e. Rump
    f. Ham
    g. Side
    h. Picnic

3. Lamb wholesale cuts (refer to Appendix F)
    a. Shoulder
    b. Rack
    c. Loin
    d. Sirloin
    e. Leg
    f. Breast
    g. Foreshank

4. Beef retail cuts (refer to 2x2 Color Slide Sets from Texas A & M University)
    a. Sirloin steak
    b. Boneless sirloin steak
    c. Top sirloin butt steak

- d. Porterhouse steak
- e. T-bone steak
- f. Club steak
- g. Tenderloin steak
- h. Round steak
- i. Top round steak
- j. Bottom round steak
- k. Eye of round steak
- l. Heel of round
- m. Sirloin tip-cap on
- n. Sirloin tip-cap off
- o. Standing rump
- p. Rolled rump
- q. Flank steak
- r. Beef for stew
- s. Ground beef
- t. Shank cross cut
- u. Standing rib
- v. Rib steak
- w. Rib eye roast
- x. Rib eye steak
- y. Blade pot roast
- z. Blade steak
- aa. Arm pot roast
- bb. Arm steak
- cc. Inside chuck pot roast
- dd. Shoulder clod pot roast
- ee. Boston cut
- ff. Foreshank
- gg. Plate
- hh. Shortribs
- ii. Brisket bone-in
- jj. Corned beef brisket

5. Pork retail cuts (refer to 2x2 Color Slide Sets from Texas A & M University)

- a. Sirloin roast
- b. Centerloin roast
- c. Loin chop
- d. Rib chop
- e. Canadian style bacon
- f. Smoked loin chop
- g. Tenderloin
- h. Blade loin roast
- i. Back ribs
- j. Fresh ham (shank half)
- k. Fresh ham (butt half)
- l. Fresh ham (center slice)
- m. Fresh ham (boneless)
- n. Smoked ham (shank half)
- o. Smoked ham (butt half)
- p. Smoked ham (center slice)

q. Fresh picnic shoulder
r. Smoked picnic shoulder
s. Arm roast
t. Arm steak
u. Fresh Boston shoulder
v. Smoked Boston shoulder roll
w. Blade steak
x. Spareribs
y. Fresh side
z. Slab bacon
aa. Sliced bacon
bb. Salt side
cc. Jowl bacon
dd. Fresh pork sausage
ee. Fresh bulk sausage
ff. Salt fat back

6. Lamb retail cuts (refer to 2x2 Color Slide Sets from Texas A & M University)

   a. French leg
   b. American leg
   c. Lamb leg, sirloin half
   d. Leg steak
   e. Sirloin chops
   f. Rib roast
   g. Rib chops
   h. Loin chops
   i. Square cut shoulder
   j. Rolled shoulder
   k. Arm chop
   l. Blade chop
   m. Breast
   n. Riblets
   o. Foreshank
   p. Lamb patties

7. Variety meats (refer to 2x2 Color Slide Sets from Texas A & M University)

   a. Livers
   b. Hearts
   c. Tongues
   d. Brains or sweetbreads
   e. Kidneys

D. Marbling (refer to Live Animal Carcass Evaluation page 89 and Meat Evaluation Handbook page 21)

   1. A very important factor in judging and grading beef
   2. The intermingling of fat within the muscle (intermuscular fat)

3. Marbling is normally evaluated in the rib eye muscle at the 12th rib
4. The degrees of marbling (refer to Appendix G)

    a. Devoid to abundant are the extreme ranges
    b. Traces to abundant are the normal ranges
    c. Small to modest are the average ranges

        1) Small to modest amount of marbling must be present to grade low to average choice

5. Marbling is usually estimated from amount of external fat on live cattle

    a. Fatter cattle have the highest degree of marbling and higher quality grades
    b. Cattle with very little external fat have lowest degree of marbling and lowest quality grades

6. Length of time on full feed is related to the degree of marbling
7. Marbling is the most important factor affecting quality grade

E. Quality grading characteristics

1. Beef quality grading (refer to Meat Evaluation Handbook pages 20-22)

    a. Check list for determining quality grading (refer to Live Animal Carcass Evaluation pages 88-106)

        1) Class or kind of meat
        2) Sex classification (if applicable)
        3) Maturity evaluation based on evidences of skeletal maturity and color and texture of the rib eye muscle
        4) Marbling and firmness of the rib eye muscle
        5) Final analysis or composite quality grade

    b. Class or kind of meat and sex classification

        1) Beef, veal or calf
        2) Steer, heifer, cow beef or bullock beef

            a) Cow beef is not eligible for the prime grade
            b) Bullock beef is not applicable to commercial, cutter and canner grades

        3) Major factors to determine the sex condition

3) Major factors to determine the sex condition of beef

   a) Steer carcasses

      1.1) Rough and irregular fat in the cod region
      2.2) Relatively small pelvic area
      3.3) Small "pizzle eye"
      4.4) Curved aitch bone
      5.5) Bald spot or lean spot above the aitch bone

   b) Heifer carcasses

      1.1) Very smooth fat in the udder region
      2.2) Slightly larger pelvic area
      3.3) Straighter aitch bone
      4.4) Slightly less thickly fleshed

   c) Cow carcasses

      1.1) Large pelvic cavity
      2.2) Nearly straight aitch bone
      3.3) Hips are slightly prominent
      4.4) Bones are usually hard and white
      5.5) Cartilages on the ends of the chine bones are often completely ossified

   d) Bullock and bull carcasses

      1.1) Large pizzle eye
      2.2) Pizzle muscle that is large, dark red in color and coarse in texture
      3.3) Noticeable crest
      4.4) Small amounts of external fat
      5.5) Lean is frequently dark red in color
      6.6) Difference between bullock and bull is based solely on their evidence of skeletal maturity

c. Maturity evaluation

   1) Maturity in the skeleton is noted
   2) The color and texture of the lean are evaluated from the rib eye muscle
   3) Maturity groupings (referred to by litters)

      a) "A" maturity group

         1.1) Soft, porous chine bones
         2.2) Soft, pearly white cartilages

- 3.3) Rib bones narrow and red
- 4.4) The sacral vertebrae shows distinct separation
- 5.5) Cartilage is present on the split aitch bone
- 6.6) Lean is fine and smooth in texture and light red in color

b) "E" maturity group

- 1.1) The opposite end of the spectrum from the A group
- 2.2) Hard, white chine bones
- 3.3) The cartilages being barely visible
- 4.4) Rib bones are wide and flat
- 5.5) Rib eye muscle is dark red and coarse in texture
- 6.6) Decline in thickness of muscling
- 7.7) Increased irregularity of shape and deposition of external fat

d. Degree of marbling and firmness of rib eye muscle

1) Beef with "A" maturity

- a) Maturity is not a factor in determining the quality grade
- b) Increasing marbling is not required to compensate for an increase in maturity

2) The other maturity groups

- a) There is a progressive increase in the marbling requirement with progressive increases in maturity

2. Pork quality grading (refer to Meat Evaluation Handbook pages 46-50)

a. Check list for quality grading (refer to Live Animal Carcass Evaluation pages 39-55)

- 1) Sex and/or sex condition
- 2) Carcasses with acceptable lean quality
- 3) Carcasses with unacceptable lean quality

b. Sex condition

1) Barrow carcasses

- a) Small pizzle eye
- b) The typical pocket in the split edge of the belly where the sheath was removed

2) Gilt carcasses
    - a) Smooth split edge of the belly
    - b) No pizzle eye
    - c) Lack of development of mammary tissue

3) Sow carcasses
    - a) Smooth split edge of belly
    - b) Mammary tissue has developed

4) Stag carcasses
    - a) Pocket in the split edge of the belly
    - b) Pizzle eye is larger
    - c) Heavier shoulders
    - d) Thick skin over shoulders
    - e) Large bones and joints
    - f) Dark red color of lean

5) Boar carcasses
    - a) Same characteristics as a stag
    - b) Only characteristics are more pronounced

c. Carcasses and lean quality

1) Best observed in the cut surface of a major muscle
2) Quality indicating characteristics
    - a) Marbling
    - b) Firmness
    - c) Color

3) Poor quality indicating characteristics
    - a) Unacceptable lean quality
    - b) Bellies too thin to be suitable for bacon production
    - c) Soft oily carcasses

3. Lamb quality grading (refer to Meat Evaluation Handbook pages 58-59 and 63-64)

a. Check list for quality grading (refer to Live Animal Carcass Evaluation pages 133-154)

1) Determination of class
2) Feathering between the ribs
3) Fat streaking inside flank muscle
4) Firmness of fat and lean

b. Lamb carcasses

1) Exhibit break in joints on both front shanks
2) Slightly wide and moderately flat rib bones
3) Light red color of ribs
4) Fine texture of lean

c. Yearling carcasses

1) Have either break joints or spool joints
2) Moderately wide rib bones which tend to be flat and slightly dark red in color
3) Slightly coarse texture of lean

d. Mutton carcasses

1) Always have spool joints
2) Wide, flat rib bones
3) Dark red color of ribs
4) Coarse texture of lean

e. Feathering in young animals

1) Modest (prime)
2) Slight (choice)
3) Traces (good)

f. Fat streaking in young animals

1) Small (prime)
2) Traces (choice)
3) Practically none (good)

g. Firmness of lean in young animals

1) Tend to be firm and flanks tend to be moderately full and firm (prime)
2) Tend to be moderately firm and flanks tend to be slightly full and firm (choice)
3) Slightly firm and flanks are slightly thin and soft (good)

h. Feathering the mature animals

1) Moderate (prime)
2) Small (choice)
3) Slight (good)

i. Fat streaking in mature animals

1) Modest (prime)
2) Slight (choice)
3) Traces (good)

j. Firmness of lean in mature animals
    1) Firm and flanks are moderately full and firm (prime)
    2) Moderately firm and flanks are slightly full and firm (choice)
    3) Tend to be moderately firm and flanks tend to be slightly full and firm (good)

F. Quality Grades
(refer to Meat Evaluation Handbook pages 21-22 and refer to Live Animal Carcass Evaluation page 88)

1. Beef

a. Prime
b. Choice
c. Good
d. Standard
e. Commercial
f. Utility
g. Cutter

2. Lamb

a. Prime
b. Choice
c. Good

G. Yield grade factors

1. Definition

a. Yield grade identifies differences in carcass cutability
b. Yield grade utilizes closely, trimmed retail cuts

2. Beef (refer to Meat Evaluation Handbook page 23 and refer to Live Animal Carcass Evaluation pages 100-101)

a. The four cuts used in beef yield grading

1) The round
2) The loin
3) The rib
4) The chuck

b. The four factors to determine beef yield grade

   1) The amount of external fat
   2) The amount of kidney, pelvic and heart fat
   3) The area of rib eye muscle
   4) The carcass weight

c. The amount of external fat

   1) Evaluated in terms of thickness of fat over the rib eye muscle
   2) Measured perpendicular to the outside surface at a point 3/4 of the length of the rib eye from its chine bone end

d. Kidney, pelvic and heart fat

   1) Evaluated subjectively
   2) Expressed as a percent of the carcass weight

e. Area of rib eye muscle

   1) Determined where the muscle is exposed by ribbing between the 12th and 13th ribs
   2) May be subjectively evaluated
   3) May be measured by a grid

f. Hot carcass weight or chilled carcass weight x 102%

   1) Obtained from tag on the carcass

3. Lamb (refer to Meat Evaluation Handbook pages 60-61 and refer to Live Animal Carcass Evaluation pages 147-149)

   a. The four cuts used in lamb yield grading

      1) The leg
      2) The loin
      3) The rack
      4) The shoulder

   b. The three factors in determining lamb yield grades

      1) The amount of external fat
      2) The amount of kidney and pelvic fat
      3) Conformation grade of the leg

c. External fat

1) Most important yield grade factor since it is a good indicator of the amount of fat that is trimmed in the retail cuts
2) Evaluated in terms of the thickness of fat over the center of the rib eye muscle between the 12th and 13th ribs

d. Kidney and pelvic fat

1) Evaluated subjectively
2) Expressed in percentage of carcass weight
3) As amounts of these fats increase, the percentage of retail cuts decrease

e. Conformation grade of the leg

1) Evaluation is made in terms of thirds of a grade
2) 15 is used for high prime and 1 is used for low cull
3) An increase in the conformation grade of legs increases the percentage of retail cuts

H. Yield grades
(refer to Meat Evaluation Handbook pages 33-37)

1. Beef

a. US #1
b. US #2
c. US #3
d. US #4
e. US #5

2. Lamb (refer to Live Animal Carcass Evaluation page 146 and refer to Meat Evaluation Handbook pages 65-67)

a. US #1
b. US #2
c. US #3
d. US #4
e. US #5

I. Mathematical equations for yield grades (refer to Meat Evaluation Handbook page 23 and refer to Live Animal Carcass Evaluation pages 102-103)

1. Beef

    a. Determine a preliminary yield grade by tenths

    b. Determine the final yield grade by adjusting the preliminary yield grade as necessary for variations in kidney, pelvic and heart fat from 3.5%

        1) For each percent of kidney, pelvic and heart fat more than 3.5 percent, add .2 of a grade to the preliminary yield grade

        2) For each percent of kidney, pelvic and heart fat less than 3.5 percent, subtract .2 of a grade from the preliminary grade

    c. Adjust for variations in area of rib eye from the carcass weight area of the rib eye

        1) For each square inch more than the area indicated in the weight area of rib eye schedule, subtract .3 of a grade from the preliminary yield grade

        2) For each square inch less than the area indicated in the weight area of the rib eye schedule, add .3 of a grade to the preliminary grade

2. Lamb (refer to Meat Evaluation Handbook pages 60-61 and refer to Live Animal Carcass Evaluation page 151)

    a. Determine a perliminary yield grade by hundredths to reflect the external fatness of the carcass

    b. Determine the final yield grade by adjusting the preliminary yield grade, as necessary for variations in kidney and pelvic fat from 3.5% and for variations in leg conformation grade from average choice

        1) Rate of adjustment for percent of kidney and pelvic fat

            a) For each % of kidney and pelvic fat more than 3.5 percent add 0.25 of a grade to the preliminary yield grade

            b) For each percent of kidney and pelvic fat less than 3.5% subtract 0.25 of a grade from the preliminary yield grade

2) Rate of adjustment for leg conformation grade

   a) For each 1/3 of a grade that the conformation of the legs exceeds average choice subtract 0.05 of a grade from the preliminary yield grade
   b) For each 1/3 of a grade that the conformation of the legs is less than average choice add 0.05 of a grade to the preliminary yield grade

3. Example yield grading problems

   a. Beef yield grading (refer to Appendix H)

      1)

Carcass weight	645 pounds
External fat thickness	.2 inch
Rib eye area	13.9 square inches
Kidney, pelvic and heart fat	2.5%

      2)

.2" fat	= 2.5	prelim. yield grade
645 lbs.	=+ .17	adjustment
	2.67	adjusted Y.G.
13.9 rib eye area	- .75	adjustment
	1.92	adjusted Y.G.
2.5% K.P.H.	- .20	adjustment
	1.72	final yield grade Low Prime

   b. Lamb yield grading (refer to Appendix I)

      1)

Fat thickness over rib eye	.05"
Kidney and pelvic fat	1.5%
Leg conformation	Low prime

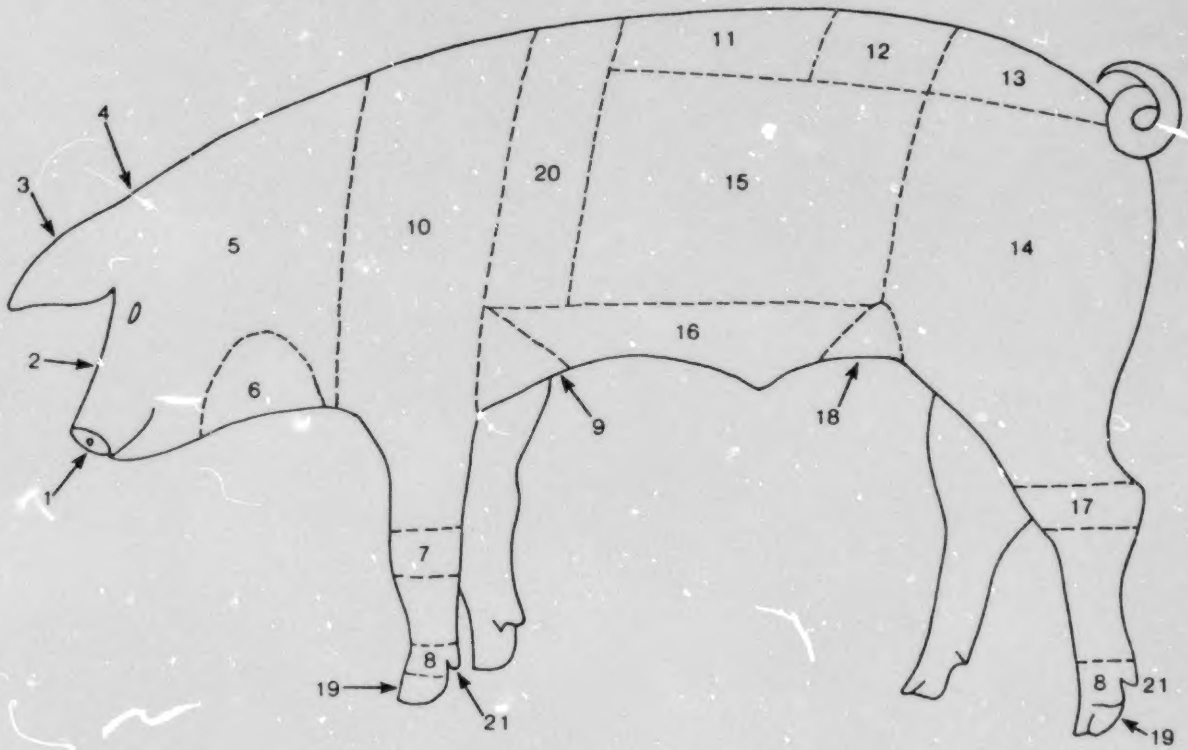
      2)

.05 inch fat	= 2.33	prelim. yield grade
1.5% kidney and pelvic fat	- .50	adjustment
	1.83	adjusted grade
Low prime leg conformation	- .10	adjustment
	1.73	final yield grade

APPENDICIES

External Parts of Swine

APPENDIX A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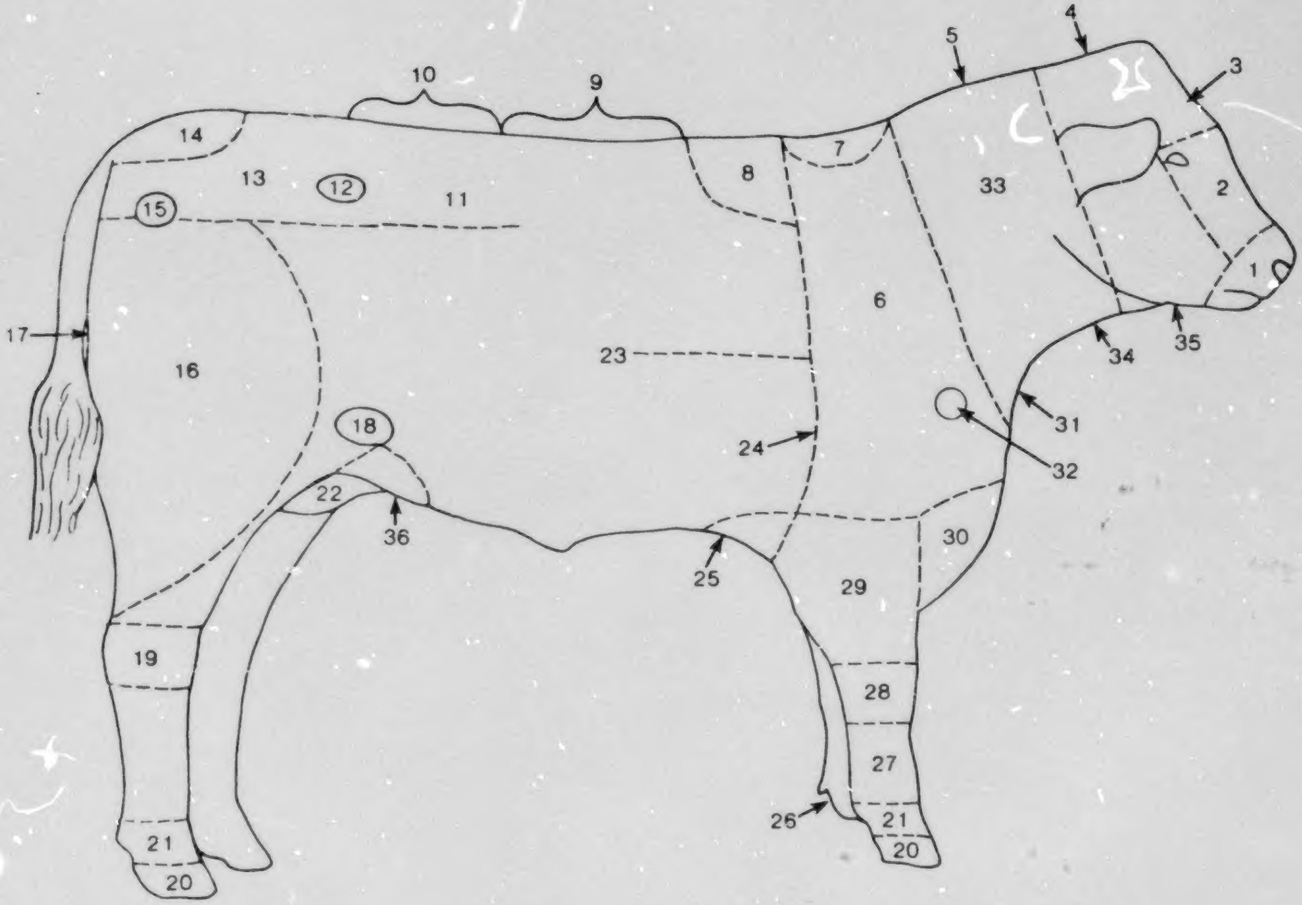
1. Nose or snout
2. Face
3. Ear
4. Poll
5. Neck
6. Jowl
7. Knee
8. Pastern
9. Fore flank
10. Shoulder
11. Back
12. Loin
13. Rump
14. Ham
15. Side
16. Belly or underline
17. Hock
18. Rear flank
19. Foot or toe
20. Forerib
21. Dew claw

APPENDIX B

External Parts of a Steer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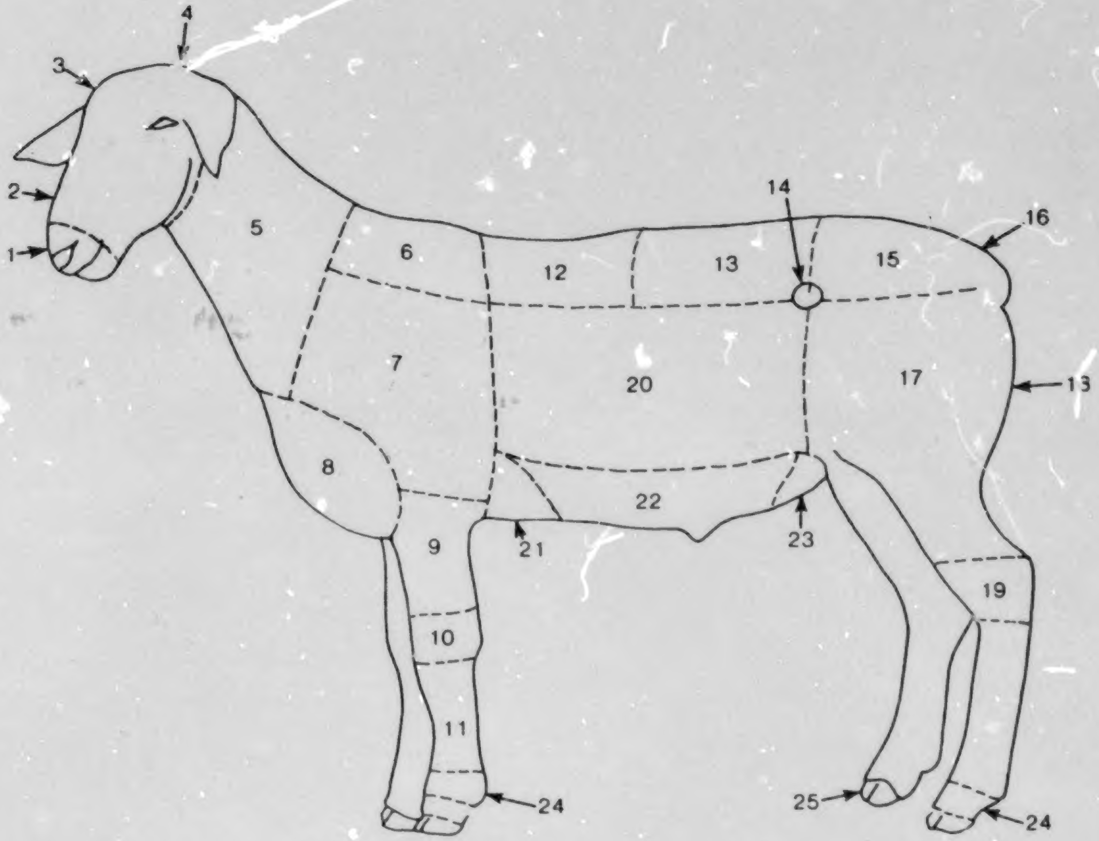
20

1. Muzzle
2. Face
3. Forehead
4. Poll
5. Crest
6. Shoulder
7. Top of shoulder
8. Crops
9. Back
10. Loin
11. Loin edge
12. Hooks or hips
13. Rump
14. Tailhead
15. Pins
16. Quarter or round
17. Twist
18. Stifle
19. Hock
20. Foot or toe
21. Pastern
22. Cod
23. Ribs
24. Heart girth
25. Foreflank
26. Dew claw
27. Cannon
28. Knee
29. Forearm
30. Brisket
31. Dewlap
32. Point of shoulder
33. Neck
34. Throat
35. Jaw
36. Rear flank

External Parts of Sheep

APPENDIX C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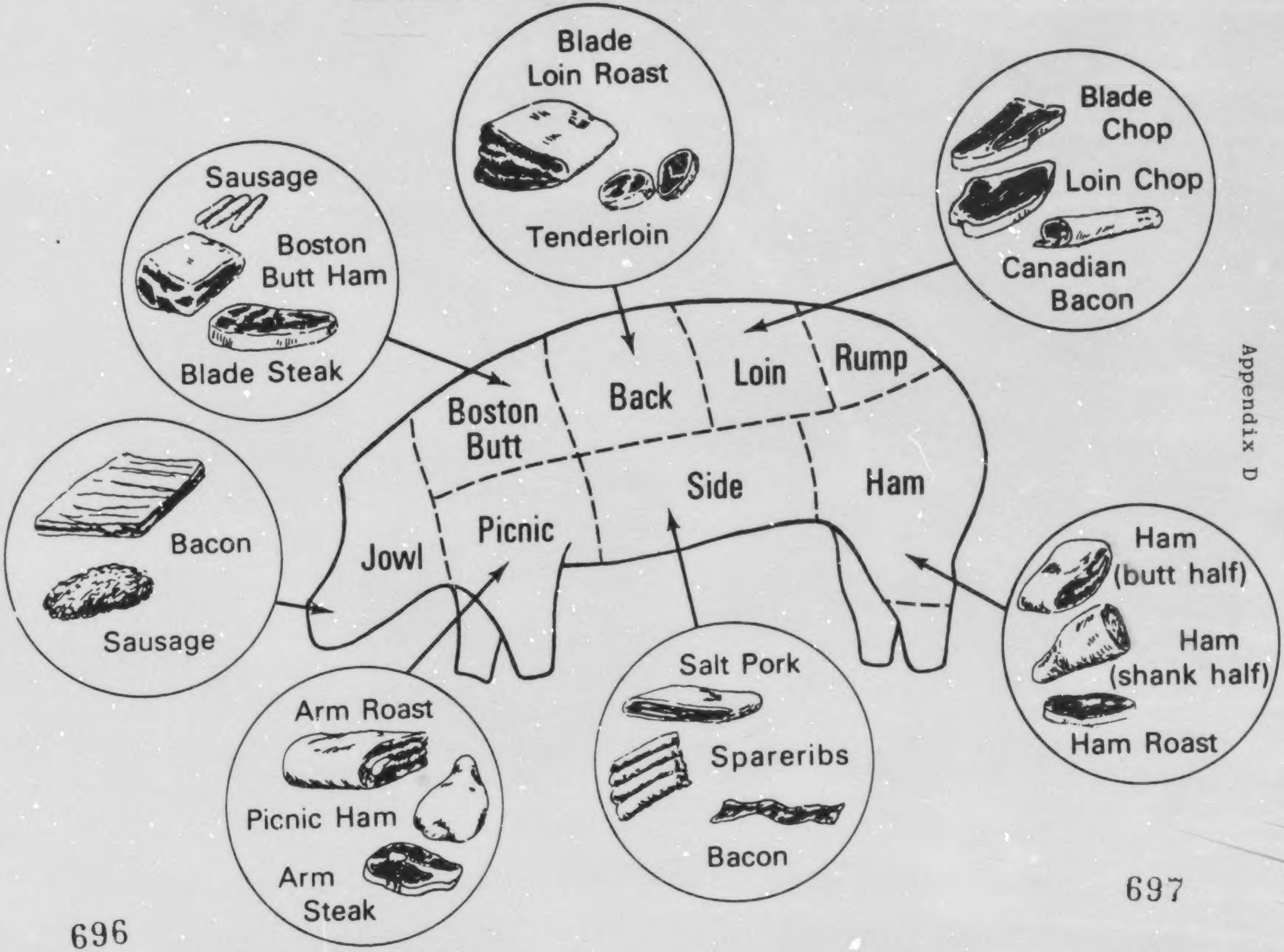
1. Muzzle
2. Face
3. Forehead
4. Poll
5. Neck
6. Top of shoulder
7. Shoulder
8. Breast or brisket
9. Forearm
10. Knee
11. Cannon
12. Back or rack
13. Loin
14. Hips
15. Rump
16. Dock
17. Leg
18. Twist
19. Hock
20. Middle
21. Fore flank
22. Belly
23. Rear flank
24. Pastern
25. Hoof

Wholesale Cuts of Pork


Blade
Loin Roast
Tenderloin
Blade
Chop
Loin Chop
Canadian
Bacon
Sausage
Boston
Butt Ham
Blade Steak
Bacon
Sausage
Boston
Butt
Back
Loin
Rump
Side
Ham
Jowl
Picnic
Arm Roast
Picnic Ham
Arm
Steak
Salt Pork
Spareribs
Bacon
Ham
(butt half)
Ham
(shank half)
Ham Roast

Appendix D

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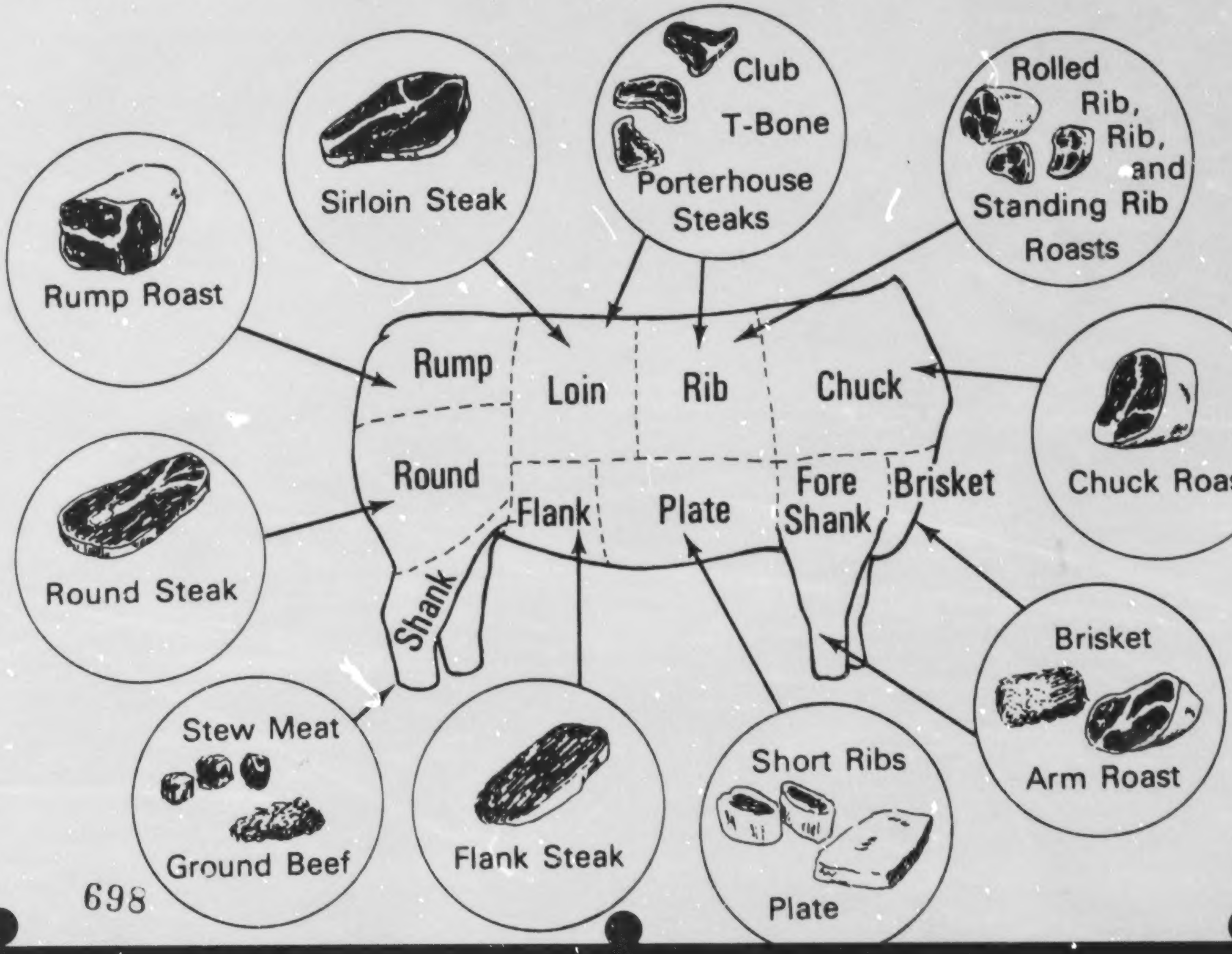
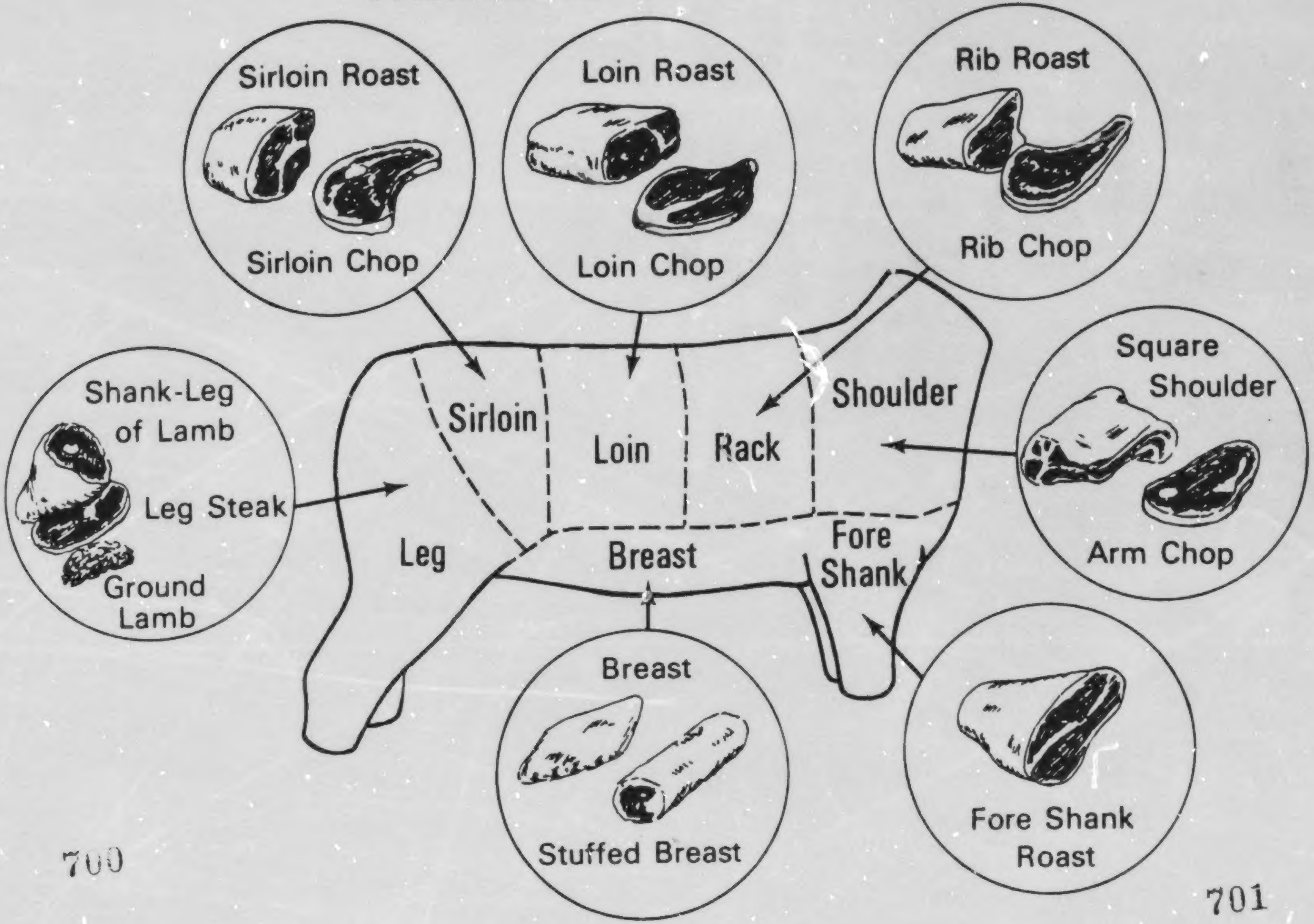
Wholesale Cuts of Beef


Rump Roast
Sirloin Steak
Club
T-Bone
Porterhouse Steaks
Rolled Rib, Rib, and Standing Rib Roasts
Chuck Roast
Rump
Loin
Rib
Chuck
Round
Flank
Plate
Fore Shank
Brisket
Shank
Round Steak
Brisket
Arm Roast
Stew Meat
Ground Beef
Flank Steak
Short Ribs
Plate

Wholesale Cuts of Lamb


Sirloin Roast
Sirloin Chop
Loin Roast
Loin Chop
Rib Roast
Rib Chop
Square Shoulder
Arm Chop
Shank-Leg of Lamb
Leg Steak
Ground Lamb
Breast
Stuffed Breast
Fore Shank Roast
Sirloin
Loin
Rack
Shoulder
Leg
Breast
Fore Shank

Appendix F

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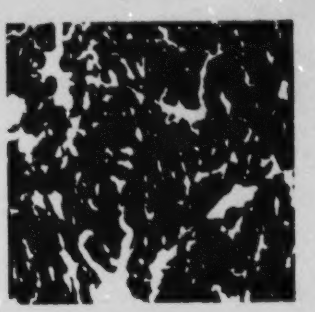
Appendix G

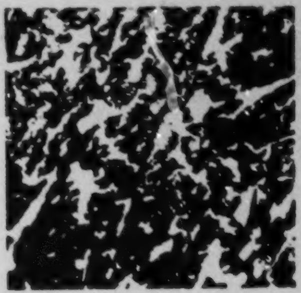
Illustrations of Marbling

Since marbling is such an important factor in judging and grading beef, the following pictures illustrate the lower limits of eight of the degrees of marbling (abundant through traces) referred to in the official United States Standards for Grades of Carcass Beef. In grading, positive consideration is given to marbling through the upper limit of "abundant". That amount is depicted by the illustration of the lower limit of "very abundant". The lowest degree of marbling, "practically devoid," is not illustrated.

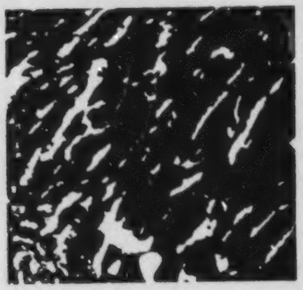
1—Very abundant



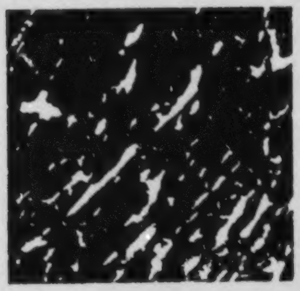
2—Abundant



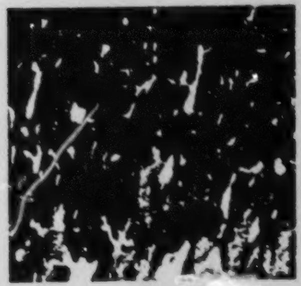
3—Moderately abundant



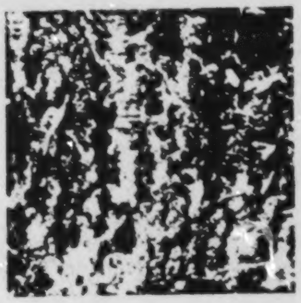
4—Slightly abundant



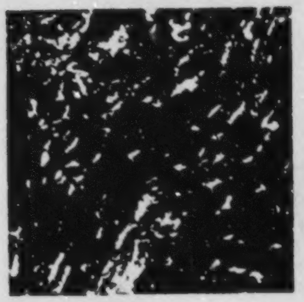
5—Moderate



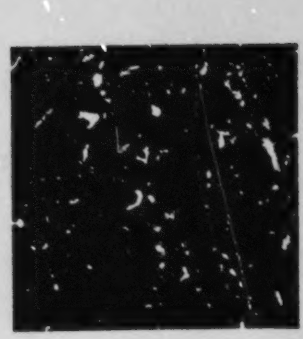
6—Modest



7—Small



8—Slight



9—Traces

Illustrations adapted from negatives furnished by New York State College of Agriculture, Cornell University

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Appendix H

A Short-Cut Method for Yield Grading Beef Carcasses

(1) Determine the Preliminary Yield Grade

A change of 0.10 inch changes the PYG by 0.25 YG.

Fat Over the Eye	PYG
0.00	2.00
0.10	2.25
0.20	2.50
0.30	2.75
0.40	3.00
0.50	3.25
0.60	3.50
0.70	3.75
0.80	4.00
0.90	4.25
1.00	4.50
1.10	4.75
1.20	5.00

Each 0.05 = 1/8 of a yield grade; thus a carcass with

0.15 has a PYG of 2.00 + 3/8 YG = 2.38 PYG

0.25 has a PYG of 2.00 + 5/8 YG = 2.63 PYG

0.50 has a PYG of 2.00 + 10/8 YG = 3.25 PYG

(2) Adjust for Carcass Weight Deviations From 600 Pounds

A change of 100 lb. changes the PYG by 0.40 YG

Carcass Weight	PYG Adjustment
350	-1.00
400	- .80
450	- .60
500	- .40
550	- .20
600	none
650	+ .20
700	+ .40
750	+ .60
800	+ .80
850	+1.00

If a carcass weighs 738 lbs. correct by multiplying 1.38 times .40 or add .55 YG to the PYG.

(3) Adjust for Rib Eye Area Deviations From 11.0 Square Inches

A change of 1 square inch changes the PYG by 0.30 YG.

Rib Eye Area (Sq. In.)	PYG Adjustment
9.0	+.60
9.5	+.45
10.0	+.30
10.5	+.15
11.0	none
11.5	-.15
12.0	-.30
12.5	-.45
13.0	-.60

If a carcass has a rib eye area of 11.3 sq. in. correct by multiplying 3.3 times .30 or subtract .99 YG from the PYG.

(4) Adjust for Percent KPH Deviations From 3.5 Percent

A change of 1 percent changes the PYG by 0.20 YG.

% KPH Fat	PYG Adjustment
0.5	-.60
1.5	-.40
2.5	-.20
3.5	none
4.5	+.20
5.5	+.40
6.5	+.60

If a carcass has a % KPH of 5% correct by multiplying 1.5 times .20 or add .30 YG to the PYG.

(5) Complete Procedure For Determining Yield Grade

CW	FT	REA	% KPH
585	0.75	13.3	4

a. 0.75 = 2.00 + 15/8 or 3.88 = PYG
b. 600 minus 585 = 15; .15 times .40 = minus 0.06
c. 13.3 minus 11.0 = 2.3; 2.3 times .30 = minus 0.69
d. 4.0 minus 3.5 = 0.5; 0.5 times .20 = plus 0.10

		3.88	(PYG)	
	minus	0.06	(CW)	
FINAL		3.82		
YIELD	minus	0.69	(REA)	$\boxed{3.2}$
GRADE		3.13		
	plus	0.10	(KPH)	
		3.23		

Appendix I

LIVE LAMBS AND LAMB CARCASSES

The preliminary yield grade is determined from the following table based on the estimated adjusted thickness of fat over the rib eye between the 12th and 13th ribs:

Fat Over Rib Eye	Preliminary Yield Grade	Fat Over Rib Eye	Preliminary Yield Grade
.05 inch	2.33	.35	4.33
.10	2.67	.40	4.67
.15	3.00	.45	5.00
.20	3.33	.50	5.33
.25	3.67	.55	5.67
.30	4.00	.60	6.00

The adjustment for estimated percent kidney and pelvic fat is determined from the following table:

% Internal Fat	Adjustment	% Internal Fat	Adjustment
1.0	-.62	3.5	0
1.5	-.50	4.0	+.12
2.0	-.38	4.5	+.25
2.5	-.25	5.0	+.38
3.0	-.12	5.5	+.50

The adjustment for leg conformation score is determined from the following table:

Leg Score	Adjustment	Leg Score	Adjustment
6	+.25	11	0
7	+.20	12	-.05
8	+.15	13	-.10
9	+.10	14	-.15
10	+.05	15	-.20

Combine the preliminary yield grade and the adjustments to obtain the final yield grade.

Figure 10.14. Relationship of marbling and maturity as used in determining final beef carcass quality grade.

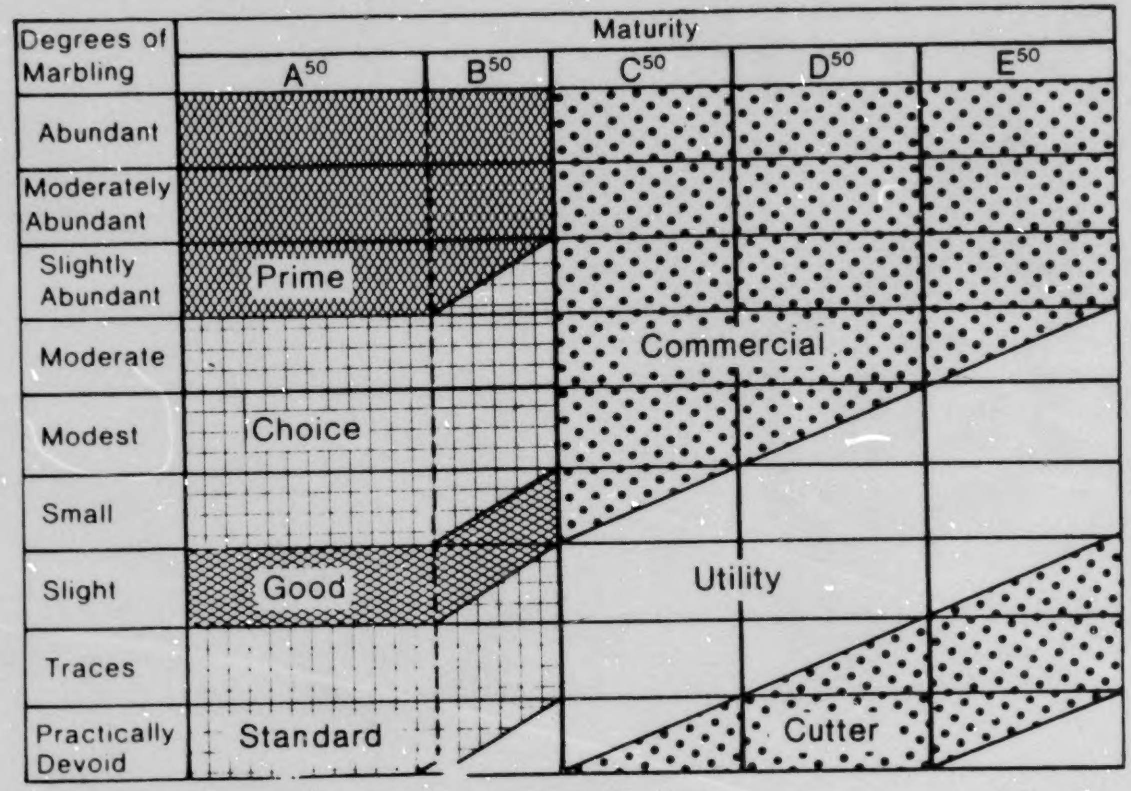
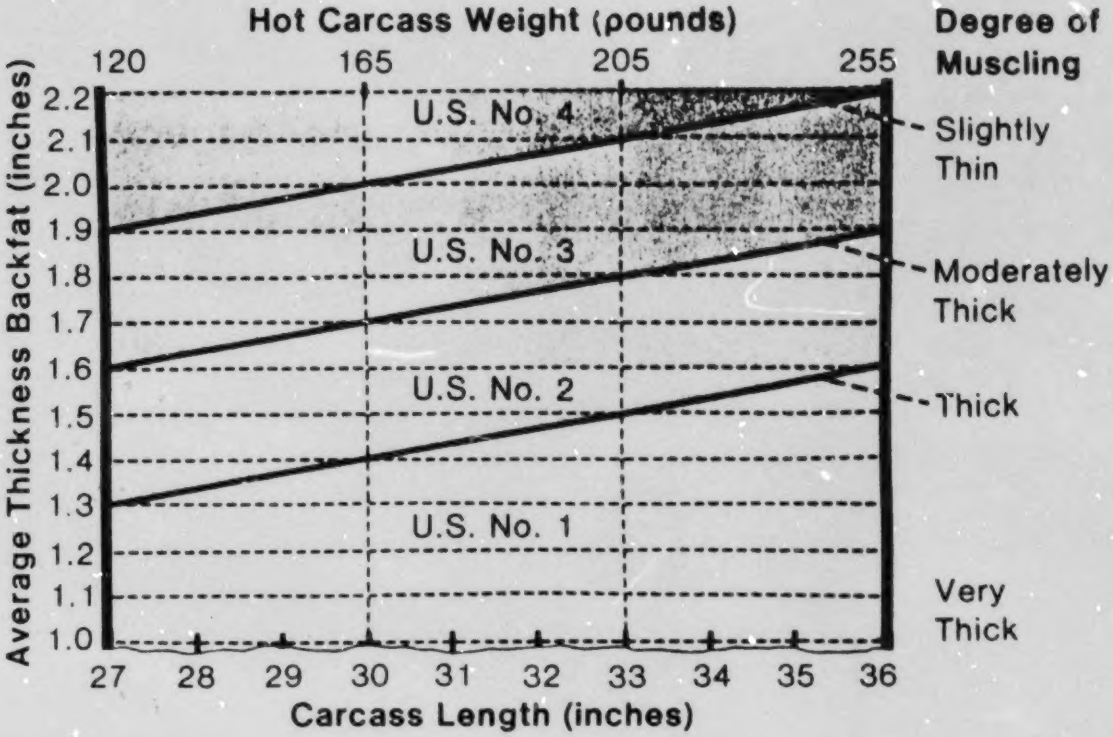

Degrees of Marbling
Maturity
A50
B50
C50
D50
E50
Abundant
Moderately Abundant
Slightly Abundant
Moderate
Modest
Small
Slight
Traces
Practically Devoid
Prime
Choice
Good
Standard
Commercial
Utility
Cutter

Figure 6.10. Pork carcass grading chart showing the relationship of average backfat thickness, degree of muscling, hot carcass weight and carcass length.



Minimum Requirements for Feathering, Fat Streakings in the Flank, and Firmness for Lamb Carcasses by Grade and Maturity*

Grade	A (Young)			B (Mature)		
	Feathering	Fat Streakings in Flank	Firmness of Lean and Fullness and Firmness of Flank	Feathering	Fat Streakings in Flank	Firmness of Lean and Fullness and Firmness of Flank
Prime	Modest	Small	Tend to be firm and flanks tend to be moderately full and firm	Moderate	Modest	Firm and flanks are moderately full and firm
Choice	Slight	Traces	Tend to be moderately firm and flanks tend to be slightly full and firm	Small	Slight	Moderately firm and flanks are slightly full and firm
Good	Traces	Practically None	Slightly firm and flanks are slightly thin and soft	Slight	Traces	Tend to be moderately firm and flanks tend to be slightly full and firm

*These minimum requirements are applicable only to the quality aspects of the grade and do not reflect any compensations for superior or inferior conformation. The degrees of feathering, fat streakings in the flank, and firmness illustrate combinations of minimum quality requirements for lamb carcasses which develop typically in these factors. However, since only the composite of the three quality factors must equal the minimum requirements and each is given equal consideration, it is possible for one or two of these quality factors to be less than the minimum specified if the other(s) is sufficiently superior to compensate for the deficiency.

Figure 14.12. A diagram showing the relationship of maturity, feathering, flank streaking and flank fullness and firmness for quality grading lamb carcasses.

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BERRY PRODUCTION

Plant Science --- Local Adaption

Introduction:

This unit was developed by Les Geren. It is provided as a Plant Science Local Adaption Option Unit. The instructor and local advisory committee should select which plant science unit fits the community best and present that unit. There are six plant science local adaption units provided in this curriculum guide, they include:

1. Berry Production
2. Grass Seed Production
3. Nursery Production
4. Landscape Design
5. Christmas Tree Production
6. Range

Specific Objectives:

Upon completion of this unit, the student will be able to:

1. Select an appropriate site for high yield production.
2. Know the steps in planning and instrumenting site preparation for high quality yields.
3. Select a plant variety favorable for a site, climate and market.
4. Describe the methods of planting, spacing and post placement in preparation of small fruits.
5. Name the steps necessary for annual berry production.
6. Discuss two methods of berry harvesting and the process in selecting harvesting method and preparing field for that procedure.
7. Select a system of marketing for highest possible net returns in that particular area.
8. Understand safe handling of pesticides.

9. Calibrate a sprayer.
10. Identify common insect, disease and weed problems in berry production.

References:

1. Strawberry Production Guide
   Edited by William P. A. Scheer
   Area Extension Agent
   Pierce & King Counties - Washington
2. Raspberry Production Guide
   Edited by William P. A. Scheer
   Area Extension Agent
   Pierce & King Counties - Washington
3. Spray Guide for Cane Fruits in Oregon
   Extension Circular 852
4. Berry Production Guide
   Department of Agriculture and
   University of British Columbia
5. Oregon State University Fertilizer Guide
   FG 49
   FG 48
   FG 51
   FG 14
   FG 50
6. Blackberry Culture
   Prepared by Ralph Clark FS 67
   Oregon Extension Service
7. Identification & Judging
   Wilson & Larson
8. Littau Harvester Company
   Aumsville, Oregon 97325
9. County Extension Service
10. Local Farmers

Instructor Activities:

1. Duplicate materials for students.
2. Line up field trips for important berry varieties of the local area.

3. Use Extension agent and local producers as references, guest speakers, and field trip hosts for this unit.
4. Have students make insect and/or weed collections.

Student Activities:

1. Participate in discussion and demonstrations.
2. Make insect and/or weed collections for common pest problems in berry production.
3. If possible, cane and tie berries.
4. Develop a fertilizer recommendations for berries.

Appendices:

1. Appendix A: Insect, Mites and Disease Identification Guide
2. Appendix B: Common Raspberry Varieties
3. Appendix C: Planting Guides
4. Appendix D: Grower's Spray Record Chart
5. Appendix E: Spray Calibration Information
6. Appendix F: Fertilizer Guides: Loganberries, Boysenberries and Marion Blackberries
   Thornless Evergreen Blackberries
   Black Raspberries
   Red Raspberries
   Strawberries
7. Appendix G: Enterprise Data Sheets: Loganberries
   Boysenberries
   Marion Blackberries
   Thornless Evergreen Blackberries
   Black Raspberries
   Red Raspberries
   Strawberries
8. Appendix H: Strawberry Yearly Calendar
   Cane Berry Yearly Calendar
9. Appendix I: Dilution Table for Pesticides
   Weights and Measures
10. Appendix J: Definitions of Frequently Encountered Terms

SUBJECT MATTER OUTLINE

SMALL FRUIT PRODUCTION

I. Site Selection

   A. Land and Crop History

      1. Knowledge of flood possibilities
      2. Formation of small ponds for all or part of the year
      3. Previous crops grown

         a. If berries were the former crop, consideration should be made to plant disease and problems former plants had
         b. Ground should be tested for harmful plant pest
         c. Survey should be of potential weed problems
         d. Best if site is selected 2-3 years in advance

            1) Use of cover crops for weed control
            2) Also will help incorporate organic matter in soil for increased fertility and soil aeration

   B. Land Use Class

      1. Can be done by self analysis
      2. Most easily and accurately conducted by your local SCS (Soil Conservation Service Office)

         a. They use a combination of aerial photographs and on-site observation
         b. Beneficial for determining the potential of your property
         c. If using a multi-cropping plan, can be helpful in crop placement
         d. Coupled with soil test and careful plant selection can determine potential yield

   C. Type of Soil

      1. Small fruits prefer deep, well drained soils
      2. Loam or sandy loam soils preferred
      3. Clay type soils or areas of high water tables are subject to

         a. Problem may be helped with the use of deep drains
         b. Very expensive process and alternative sites should be viewed carefully

4. Areas of reasonable slope increase surface drainage and therefore reduce potential drainage problems
5. Soil depths exceeding four feet preferred for root space and drainage
6. Streaks of sandy type soils throughout the area make it difficult to maintain a uniform field
7. Extremely porous field increase the need for heavier fertilizing program and need for irrigation
8. If mechanical harvesting is being considered, then land slope can be a factor

    a. South or Southwest slopes subject to spring frost drainage and summer drought
    b. Southerly slopes tend to harvest earlier which may be more desirable for a fresh market

D. Soil Analysis and pH Test

1. Always helpful in site selection to determine the potential fertility problems and pH adjustments necessary prior to plant
2. This information may also be a help in determining type of berry as well as specific variety
3. If advanced planning is being used you can change and improve soil fertility using heavy lime applications and barnyard, poultry and green manure crops

E. Area Population

1. Immediate population numbers such as housing developments, multi-unit housing or trailer parks are a factor because of harassment and lower yields
2. Each time a farmer sprays people become concerned for themselves, their pets, or their prized petunia
3. Usually the ones that complain the most are the first ones to jump the fence at harvest time and pick a few (5 to 19 lbs) for family and friends

II. Soil Preparation

A. Nematode Test

1. Nematodes are microscopic worms invisible to the naked eye
2. Feed on plant roots thus reducing yields tremendously
3. Use only plants known to be free from nematodes

    a. Best treatment done during August or early September
    b. Nematodes tend to be spotty throughout the field and careful sampling must be done

5. Procedure for testing
    a. Collect soil from top 8-12 inches
    b. Sample must be clean from sods, lumps or crop debris
    c. Should have 20 to 30 locations in field each of uniform quantity
    d. Avoid very wet soils or sampling when temperature is below $13^{O}C$ ($55^{O}F$)
    e. Mix thoroughly and send in a reasonable size sample
    f. Do not allow sample to air dry and treat with care, since only live nematodes can be counted
    g. Store at room temperature
    h. Send to local testing station

B. Preplanting Preparation

1. If possible, two years prior to planting, put on large quantities of manure. Six to twelve tons to the acre
    a. Increase soil permability and drainage
    b. Makes soil lighter for aeration and nutrient availability
    c. Must be supplement with commercial fertilizers for maximum plant growth
2. Follow up with a green manure crop the year before planting for weed control and as a cover crop
3. Take care of weed problems before planting and make your cropping more efficient and less costly
    a. Effective ground tillage and cropping best method of reducing large infestation of perennial weeds
    b. Spraying effective perennial herbicides in late summer very effective for hard to get grasses
    c. Soil sterilants are controversive as to total effectiveness
        1) High cost per acre compared to other herbicides
        2) Highly effective but some feel an over kill method
        3) Some farmers indicated higher yields due to nutrient release properties of soil sterilants

d. Fumigation if fungus or nematodes are present

1) Soil temperature best 60-70° or slightly warmer
2) Soil moisture critical

a) Too high and fumigant will not penetrate
b) Too low and fumigant will escape before being effective
c) 50% to 80% of total field capacity is best
d) A rolled ball of field soil will break upon touch

3) Soil structure should be broken down and well pulverized
4) All organic material should be well decomposed
5) Soil should be sealed immediately following fumigation so not to allow it to easily escape
6) Soil should be treated 8-10 inches in depth
7) Timing is best during late summer
8) Check the Extension Service bulletin or County Agent for fumigant most widely advised at the time

4. Final land preparation is best during late summer

a. Prepare soil for appropriate chemical treatment
b. Kills winter annuals such as chickweed

5. Soil nutrient deficiencies which have been identified by an accurate soil analysis should be corrected at this time for maximum production
6. Steps in soil preparation

a. Deep plow
b. Disc once or twice
c. Light rototiling or harrowing

7. Great care in soil preparation will give a higher percentage of plant survival and increase plant and root growth
8. Other considerations

a. If ground may be worked early enough, may plant cover crop then soil rework in late winter for early spring planting
b. Must not plant cover crop too soon following soil sterilization
c. If erosion is possible, cover crop advised

III. Plant Variety Selection

A. Purchasing Certified Plants

1. Not a must but definitely highly recommended due to the non-visible plant problems that should be tested before broad spread distribution
2. Before taking any plants, should have field nematode tested
3. Should view field during production or growing season to inspect for problems
4. Should always take starts from mature fields (2-5 years) so material will be strong for transplanting
5. All cane varieties should be 1/4 to 3/8 inch in diameter and plants should have a well formed root system

B. Variety Selection

1. Plant variety should match up with your anticipated harvesting season

    a. If selling to a cannery you may want a high yield in a relatively short period of time
    b. If field marketing or selling fresh, then you may want a variety that will start early and stretch harvest season out

2. Size of berry is important

    a. Berries are marketed by weight and large berries weigh more
    b. Some large fruit varieties more susceptible to fruit rot or mechanical harvesting damage

C. New Plants Should Be Handled with Care

1. Must not knock off root hairs
2. The younger the parent field, the sooner the plant should be planted following digging
3. If healthy plants are collected during the dormant period they may be healed in for early spring use
4. Plant roots should never be allowed to dry out

D. Plant Source

1. You should contact your County Agent as he has a list of certified growers in a reasonable distance
2. Your local cannery is also a good resource for obtaining planting stock

E. For Assistance in Selecting a Plant Variety, see Appendix B

IV. Planting

A. Row Spacing

1. Cane Type Fruits

   a. 2½ to 3 feet apart for raspberries
   b. Trailing type berries 8 to 10 feet between plants
   c. Should have 8 to 10 feet between rows
   d. Most tractors and cultivating equipment require larger spacing
   e. Must have in most cases, 9 or 10 feet between rows for mechanical harvesting
   f. If planning mechanical harvesting must have a 20 foot turn around space at each end of the rows

2. Strawberries

   a. Plants should set 24-30 inches apart
   b. Rows should be from 36 to 48 inches apart pending soil quality and type of tillage equipment

3. Some consideration should be given to center cross roads in fields with extremely long rows, generally for easier management during harvest
4. For plant per acre recommendations see Appendix C

B. Planting

1. Best planting early spring, as soon as ground can be worked
2. Cane berries earlier than strawberries, due to their dormant condition
3. Caution in planting too soon when soil is cold and wet. Higher plant mortality may result especially in strawberries
4. Planting too late in the spring may require irrigation for plant survival
5. Late planting is also hard on plants, regardless if healed in and stored or freshly dug. Heavy root damage due to being moved after new root growth
6. Rows generally run North and South so the sun will cross over
7. Planting may be done by hand or by mechanical means

   a. Mechanical planting generally done with a nursery type planting machine

      1) Most generally need to walk behind planting machine and firm soil around each plant and also check for skips
      2) Best suited for strawberry planting
      3) Also used frequently in raspberry planting

- b. Hand planting is most common
    - 1) Generally a two person operation, one on the spade and one planting
    - 2) Must be sure to gently place soil around plants and firm it in
- c. Regardless of planting method a strong attempt should be made to assure that rows are straight to the point of literally stringing them off
- d. Some advantage to making even diagonal rows; so that cross tilling may be done until trellis are in place
- e. Planting depth should be about one inch above digging depth so that when planted and soil is settled it will be near the planting depth

C. Post Planting Proceures

1. Cane type berries should have their tops cut off about 6-8 inches above the ground for good growth
2. Often a light banding of fertilizing is done following planting or in the later spring to help establish the plants
3. An additional soil test at this time will help recommend necessary spring fertilization
4. For cane fruits
    - a. Generally only use one wire for mechanical harvesting
    - b. Two and sometimes three wires used if hand picking
    - c. For mechanical harvesting wires should be placed slightly higher than if hand picking
    - d. Post should be placed about twenty-five to forty feet apart depending on plant variety
    - e. Little difference between metal or wire post, cost and ease
    - f. End post should be braced because that is where the majority of the stress is on the wire and post
5. Hard or soft wire
    - a. Soft wire more expensive but easier to work with
    - b. Hard wire less expensive but harder to work with
    - c. Some farmers feel due to the cost difference and only tightening wires once per year, hard wire is a better buy

V. Annual Preparation

- A. Chemical Safety
  - 1. Know Your Chemicals
    - a. Know how effective chemicals are and its hazards
    - b. READ the label, even the small print
    - c. Only use when actually needed and only for their recommended problems
  - 2. Protective Clothing
    - a. Full protective cover must be worn
    - b. Use rubber or neoprene gloves when mixing any pesticides
  - 3. Respirators
    - a. Must be worn when specified on label
    - b. Make sure respirator is rated to give protection for the chemical you intend
    - c. Filters must be replaced to remain effective
    - d. Follow respirator care and cleaning recommendation
  - 4. Disposal of unwanted or out of date chemicals
    - a. Calculate accurately the amount of chemical needed so that a minimal amount is left over
    - b. Chemicals do not have an unlimited life and are a danger if needlessly kept on hand
    - c. Drain small amount of left over spray into a hole and cover
    - d. Chemicals must not be dumped near any waterway
    - e. Destroy or dispose of empty containers immediately
    - f. Dispose by crushing and burial in a sanitary landfill
    - g. If no landfill available, bury minimum of 24 inches not near a water supply
    - h. Paper packages best to be buried
      - 1) May be burned unless stated on package otherwise
      - 2) Many fumes may be toxic to plants and to humans
      - 3) Always bury ashes
    - i. Be sure glass jars and metal containers are crushed or punched with holes to render them useless

5. Storage
    a. Keep chemicals dry
    b. Be sure they are out of reach of children and pets
    c. They must be stored in a locked shed with a ventilation system
    d. Store volatile herbicides separately from other pesticides
    e. Always store chemicals in their original containers
    f. Keep chemicals closed tightly
    g. Dispose of chemicals
        1) No longer required
        2) No longer legal
        3) Containers which are unmarked, corroded or damaged

6. Symptoms of Pesticide Poisoning
    a. If any illness or abnormal condition occurs during or after exposure to toxic chemicals see a doctor immediately
    b. Provide doctor with label information for diagnosis assistance

7. Poison Control Centers
    a. Available at nearest hospital and staffed on a twenty-four hour basis
    b. Usually listed on inside telephone directory under "Emergency Only"

8. After Applying Pesticides
    a. Clean the equipment thoroughly
    b. Clean and store your clothing and protective equipment
    c. Wash yourself thoroughly
    d. Observe the required waiting period before harvest or re-entering the field

9. Records
    a. Keep good records of all spray applications
    b. See Appendix D for a sample table used for this purpose

10. In the state of Oregon you must have a chemical applicators license in order to purchase many of the chemicals used in the berry industry. These may be obtained through your local Extension service for anyone over the age of 18 years

B. Available Chemicals for Insects, Weeds, Funguses and Diseases

1. Due to the rapidly changing nature of the chemical industry and to chemical improvement and the changing regulations it is very difficult to recommend any one chemical for a general problem
2. Annually the Oregon Extension Service puts out very specific guides for chemically treating weeds and plant pests
3. Other resources are your local county agent, cannery field representative, local chemical sales person and responsible neighboring farmers
4. Appendix A lists the most common plant pests and may be used as a guide for identification

C. Types of Applications

1. Chemicals for small fruits come in all forms

    a. Wettable powders
    b. Gas
    c. Liquids
    d. Granules

2. These chemicals are applied by many methods

    a. Sprays

        1) Banding
        2) Total surfaces

    b. Broadcasted
    c. Sub soil
    d. Some even by air application

3. The majority of chemicals are applied through a sprayer

    a. Sprayers must be calibrated annually to assure correct application
    b. Must be lubricated and cleaned following each use
    c. Extra protection should be taken following spraying season before storage

        1) Should be thoroughly cleaned including the use of a neutralizer
        2) Must be completely drained including pump to prevent freezing
        3) A light oil type product should coat metal parts to prevent corrosion or rust

    d. Appendix E may be helpful in calibrating your liquid sprayer

D. Soil and Leaf Analysis

1. Scientists are now being able to collect as much information through leaf analysis as through soil analysis
2. Leaf and soil analysis should be taken at the same time. It should be done following harvesting but well before the freeze
3. Sample bags and information are available through your Extension service
4. Following results: You compare the results to the fertilizer recommendation page provided through Oregon State University and determine nutrient requirements for your field for the following year. See Appendix F for data sheet
5. For special nutrient requirements fertilizer formulation may be made up for your particular field through your local co-op, chemical supplier or in some cases through your cannery

E. Mechanical Weed Controls

1. Always important not just for weed control but for soil aeration and water perculation
2. Most common method is through tillage not to exceed two to three inches, due to the fact that the majority of the feeder roots lie in the top six inches of soil
3. Avoid deep cultivation
4. Some hand hoeing is usually needed to keep down shoots and weeds between hills in the rows
5. Number of hand hoeings is usually determined by the quantity of herbicides used
6. Basal cane burning is often used in active growing fields

    a. Eases picking
    b. Increase yields
    c. Lessens fruit rot
    d. It reduces

        1) Number of lower leaves
        2) Number of extra toil canes during harvest
        3) Weeds between hills

    e. Procedure

        1) Apply in April when new shoots are four to eight inches high
        2) Usually only applied once
        3) Use a product called dinitro-ortho-sec mixed with superior spray oil

4) Foliage must be thoroughly wetted
5) Insufficient coverage will result in incomplete kill
6) Best to spray on sunny day with temperatures between 50 and 70 degrees. Do not spray on hot and/or windy days

7. Equipment both mechanical and hand tools should be thoroughly cleaned, sharpened and lubricated following use especially at end of season

F. Use of Bees in Small Fruit Production

1. Majority of pollination is done by insects with the bee the primary insect involved
2. Some varieties more self pollinating than others
3. Adding bees can increase pollination rate and yield as high as 200 to 300%, depending on wild bee activity in your area
4. Bees should be placed in, just as bloom begins and taken out following blossoming, so as not to endanger the bees with your insecticide spray program
5. Hives should be added to your field at the rate of one to two hives per acre
6. Be cautious of "Bee Poisoning"

   a. Do not spray with insecticide while fruit blossoms are open
   b. This is the period of greatest danger for wild bees as well as domestic types
   c. If spray must be applied select one less harmful to bees and apply during the evening when bees are not foraging
   d. Seven and most organic phosphate insecticides are especially toxic to bees. Warn nearby beekeepers if these materials are to be used

G. Caning and Tying

1. Caning is the process of removing last seasons fruiting canes

   a. May be done anytime following harvesting
   b. Early pruning allows all available nutrients being funneled into next year's cane
   c. In extreme cold or snow areas they may be left until after the severe winter for protection
   d. Early pruning allows the use of fall herbicides and insecticides as well as a fall cover crop

2. Tying is the process of securing the canes to the wires
    a. Wires should be tightened each year before tying
    b. Select eight to twelve canes per plant depending on field health
    c. Remove all extra and weak canes
    d. Do not top until after winter due to the possibility of freezer burn
    e. Many farmers do not top but tie the cane tops over and wrap as in trailing berries
    f. With raspberries if you are topping remove at four and one half feet for hand picking and five and one half feet for mechanical harvesting.

H. Cold Injury

1. Usually results from
    a. Low temperature in early winter before hardened off
    b. Low mid winter temperatures with drying winds
    c. Sudden cold during late winter
    d. Frost after growth has started in spring

2. Prevention
    a. Irrigation, if available, should be discontinued following harvesting
    b. No nitrogen applications later than bloom period
    c. No cultivation after mid August to slow growth
    d. Natural wind breaks will help
    e. Adequate soil nutrition so as not to have weak canes

I. Irrigation

1. Berries in Northwestern Oregon seldom need irrigation
2. Late bearing trailing type berries have greater advantage or need no irrigation as opposed to strawberries and raspberries
3. Usually a convenience if available, seldom worth the capital investment necessary to create and install an effective system
4. Use during dry spells and often beneficial just before berry harvest
5. If used during harvest, often run the risk of causing fruit rot

J. See Appendix G for a schedule of activities throughout the calendar year

VI. Harvesting

A. Selection of Harvest Method

1. Should be done prior to planting time and should set up field for desired method
2. Surveying of manpower availability is the most determining factor for selection of harvest methods

    a. Conventional manpower needs were heavy during harvest so most fields were located relatively close to a populated area. Now with mechanical harvesting for cane fruits, they are moving away from populations to avoid some of those conflicts and pressures
    b. Mechanical harvesting is still not feasible in strawberry production

3. Hand vs. Mechanical Picking

    a. Hand Picking

        1) Advantages

            a) With good pickers usually higher quality fruit can be harvested just as it reaches maturity
            b) Can pick heavy and only pick each three to six days, depending on stage of harvest
            c) Much lower overhead to start the harvest season

        2) Disadvantages

            a) Availability of adequate good quality pickers
            b) The hassel of having money on hand for employee payment
            c) Not being able to take 3 or 4 days off during slow times because afraid pickers will go to another field
            d) Not being able to get that "last pick" because no one wants to pick just that little bit
            e) Weather (too hot, too cold or too wet) will keep pickers from showing up
            f) A need for ten to fifteen pickers per acre

b. Mechanical Picking

1) Advantages

   a) Pick anytime you wish i.e. day, night, rain or shine
   b) Much lower need for workers
   c) Only three or four employees per fifteen to twenty acres

2) Disadvantages

   a) High initial cost $25,000 to $40,000 depending on machine variety
   b) Poor machine operator can ruin next year's berry crops by damaging the canes, cause post damage, and poor pickers on the belt can produce large docks at cannery for improper cleaning
   c) High cost of repairs
   d) Loss of time due to machine breakdown
   e) Must have a weed free field or weed seeds will lower quality of the fruit

B. Fruit Quality

1. If using mechanical harvesting a more intensive insect control program must be implemented due to insects being shook from fruit canes
2. With good operators mechanical harvesting and hand picking fruit are near the same quality
3. During harvest always be aware of the presence of fruit rot and spray for it
4. Berries should be taken to the cannery as soon as possible
5. They cannot be held overnight without coolers or mold will set in
6. Flats, berry containers should never be set on the ground because of soil contamination
7. Berries should never be allowed to sit in hot sun; they should always be shaded due to wilt, sunburn and loss of the natural berry juices
8. Crumble berry

   a. Too few pistils develop thus the fruit will crumble on the vine or when picked
   b. Cause

      1) Lack of bee activity
      2) Lack of nutrients due to drought, fertility, damage to roots or crowns such as nematodes, symphylens, root rot, crown bore, poor drainage or deep cultivation

        3) Improper variety selection
        4) Diseases in flower or fruit
        5) Chemical damage from wrong spray or poor timing

    c. Prevention and Control

        1) Keep your field healthy and vigorously growing
        2) May be corrected in some cases if caught early

C. Machine Maintenance

    1. Must remember to protect your large investment during those heavy use time
    2. General maintenance, lubrication, adjust mounts and an engine check should be made before a shift begins and during each lunch break

D. Personnel Management

    1. Good employees are hard to come by

        a. Careful selection should be made, they can make or break a farm
        b. Once good employees are found, they should be treasured
        c. Small bonuses for staying throughout the season, or parties to celebrate end of harvest helps kids forget sore knees, tired backs and early hours
        d. Set up a paying schedule and stick to it. Nothing makes for hard feelings more than a late or worse yet an incorrect pay check
        e. Field management

            1) Keep an eye on individual progress
            2) Check crates and rows for quality picking
            3) Have weight stations, parking, water, restrooms and shaded lunch area close to picking not to exceed 300-400 feet, don't try to inconvenience them
            4) Have extra pickers, usually 20% don't show and 25% quit after one or two days
            5) Set regular working hours, avoid middle afternoons because of poor picking attitudes and poor berry quality

2. Always be aware of labor laws
    a. Laws change often, keep abreast of them
    b. If using hourly wage, don't forget your quarterly Social Security payments
    c. With each working crew, there must be at least one card holding first aid person

VII. Marketing

A. Method of Marketing
1. Self processing
2. Field marketing
3. U-picking
4. Sell to cannery

B. Things to Consider When Selecting Marketing

1. Sell to cannery
    a. Advantages
        1) Almost always guaranteed a market
        2) Information on cultural practices
        3) Availability of operational capital
        4) Security in production for lending agencies
    b. Disadvantages
        1) Locked into a marketing system
        2) At the mercy of cannery for a fair price

2. Self processing
    a. Advantages
        1) Usually a higher price, due to vertically integrated management schemes
        2) Opportunity to make extra money if price goes up during off season
        3) Can assure a quality product
    b. Disadvantages
        1) If price falls can take large loss
        2) Increase management time necessary
        3) Hard to borrow against
        4) Large capital invested to start operation
        5) Additional federal regulation to follow
        6) Larger labor requirement
        7) Must watch market trends carefully until fruit sold
        8) Larger acreages necessary to make it feasible

3. Field Marketing and U-picking

   a. Advantages

      1) Higher profit
      2) Less labor required
      3) Less processing necessary

   b. Disadvantage

      1) More management to maintain high quality uniform picking
      2) Cost of transporting crates
      3) Management hassels or working with the public

C. Bookkeeping

1. One of the biggest thorns in farmers' sides
2. Must set up books and do them on a continuing basis, not on an annual basis just before income taxes
3. Many local community colleges have a bookkeeping course during the slow winter months with year around follow up in order to assist you with a set of functional books that can be highly profitable to you

Appendix A

INSECT, MITES AND DISEASE IDENTIFICATION GUIDE.

1. CANE BERRIES

(Includes Marions, Santiams, Logans, Boysens, Auroras, Cascades, Chehalems, Evergreens, Red & Black Raspberries)

INSECT PESTS

ROOT WEEVILS. There are several species of weevils that attack raspberries, but their life cycles and damage done are similar. The adults are beetles which cause negligible damage by chewing notches in the margins of the leaves. Most damage is done by white, legless larvae which eat the roots of the plants. Adult obscure root weevils occasionally are contaminants of ripe berries. Since DDT can no longer be used, it is necessary to rely on foliage or soil application of less persistent insecticides. The primary means of control of the strawberry root weevil and black vine weevil is application of insecticides to the soil prior to planting. Heptachlor will remain effective for several years. If considerable notching of leaves is noted during the summer, determine the species of weevil present and treat accordingly before bloom the following year. Adult weevils are night feeders and are easiest to locate on the foliage by use of a flashlight after dark.

TWOSPOTTED SPIDER MITE. This mite is favored by warm, dry weather, and thus, seldom requires control before the postharvest period. It prefers mature leaves and feeds on the underside of the leaves. Its presence can be detected by tiny white spots appearing on the leaf surface, and severe infestations wil kill the leaves. Plants can tolerate low populations of spider mites, and treatment should not be made unless most of the leaves have a large amount of spotting. Some insecticides will kill the predaceous insects and mites which give natural control of spider mites, permitting buildup of mites. Therefore, sprays should be applied only when needed.

DRYBERRY MITE. This microscopic mite overwinters near the buds of the previous summer's new growth. In spring they lay eggs in the expanding bud, and the new generation of mites attacks the fruit soon after petal-fall and causes the druplets to become dry. Sprays are usually timed to kill the overwintering mites just before they enter the swelling bud.

RASPBERRY CANE MAGGOT. The adult insect is a fly which lays eggs near the tops of young canes. The maggot burrows into the pith and tunnels downward. Later it girdles the cane just under the bark near the tip of the cane and then continues tunneling downward in the pith. The girdling causes the part of the cane above the injury to wilt. Chemical controls are not needed. Wilted canes can be cut off near the ground and burned to destroy the maggot.

OBLIQUEBANDED LEAFROLLER. Larvae are very active, and have black heads. Over-wintering occurs in the crevices of old canes. The larvae become active in the spring, web and feed on foliage. In June and July (concurrent with red raspberry harvest) these pupate and turn into moths, which deposit eggs on foliage. These eggs hatch in from 1 to 2 weeks, producing a second generation of larvae, which feed on caneberry leaves. This generation of larvae usually occurs towards the end of raspberry harvest. These larvae will overwinter. They can be found on most all caneberries.

Examine fields in early May to determine the need for control. Use enough water to thoroughly wet the foliage and canes, and enough pressure to penetrate the centers of the plants. Chemical applications should be applied two weeks prior to anticipated bloom to prevent bee poisning. Some chemicals recommended for control persist for 10 days to 2 weeks and can kill pollinators.

ORANGE TORTRIX. The active, yellow-green larvae with brown heads, web and feed on foliage and ripening berries of all cane fruits. Both large and small larvae overwinter beneath leaves webbed to canes and in crevices. They become active in spring, web and feed on foliage and like the Obliquebanded Leafroller also later feed on ripening berries. The Orange Tortrix has three to four generations per year. Because both large and small larvae overwinter, the generations become overlapped. Therefore it is possible to find eggs, larvae, pupae, and adults in infested fields in the summer. Besides using adult pheromone traps, examine fields in early May to determine need for control, expecially if trap counts are low.

Chemical applications should be applied two weeks prior to anticipated bloom to prevent bee poisoning. Some chemicals recommended for control persist for 10 days to 2 weeks and can kill pollinators. For control on Evergreen blackberries, apply when other berries are two weeks from bloom.

If the Orange Tortrix (and the Obliquebanded leafroller) larvae are present, they will be in the bud tips or webbing the edges of leaves. The larvae of both species are rather difficult to find. Make careful examinations at 2-week intervals in all parts of the field. The Orange Tortris larvae break their winter rest and feed on the new foliage and buds when the first leaves are about fully open, usually the first 2 weeks in May. However, in the Willamette Valley this can be somewhat later, particularly at higher elevations. If it is determined a chemical control is needed at this time, prompt action is important for two reasons: there is a minimum of foliage to wet with the spray solution; and shortly after this time pupae are formed, a stage not susceptable to chemical control.

RASPBERRY CROWN BORER(ALL CANEBERRIES).

Two years are required for this insect to complete development. First year larvae about one fourth inch long over-winter. In March they begins to feed on cane buds around the crown. Feeding continues in cane bases and canes are killed. When the larvae reach one inch long they over-winter again.

Root feeding weakens all cane fruits but may kill respberries when infestations are severe. Control should be repeated for at least two years due to the two year life cycle. Both first and second year larvae will be present. Drenches should be applied to lower canes and the crown as a spring drench to avoid killing the valuable egg parasite of borer which is present in the fall.

STRAWBERRY ROOT WEEVILS.- (OTIORHYNCHUS SPP.) All cane fruits are susceptible to injury but red reapberries are most seriously damaged Larvae over-winter two to eight inches below the soil surface. The white, legless larvae with tan heads feed on small roots and later in the cambium of larger roots and crowns. Adults are black-snout beetles which appear from May to July. They sometimes get picked with fruit and cause a contamination problem.

New plantings can be protected for a few years by incorporating a recommended insecticide thoroughly into the upper six inches of soil prior to planting. Future land use should be considered prior to treatments since some root crops following in the treated soils may become contaminated with illegal residues.

Several applications may be necessary to control adult weevils and prevent them from laying eggs or contaminating fruit.

OBSCURE ROOT WEEVIL. The brown gray adults, with a wavy line across the wing covers, feed on foliage causing severe ragging. They are active during harvest and may create a contamination problem.

SPIDER MITES. Adults over-winter on weeds or debris at the base of plants. These 8-legged animals about 1/50th inch long vary in color from light tan to greenish. Use a 10X hand lens to more easily see mites. Feeding reduces plant vigor and if populations are high they may cause leaves to turn brown and drop off prematurely. Mites have numerous generations per season and usually reach large population levels between July and September. The use of Sevin for leafroller control can aggravate mite problems.

REDBERRY MITE (PRIMARILY BLACKBERRIES). These very small (two hundreth of an inch long) Eriophyid mites are perennial pests of wild and cultivated blackberries in Oregon. The mites feed on the fruit at the bases of developing drupelets. In so doing, they cause entire berries of individual drupelets to remain green or red with a very hard character and bitter taste. These fruits are unmarketable.

The adult mites spend the winter in bud scales of the canes. The mites migrate from the cane to developing fruit and blossoms in the summer. The pest is most serious on the later maturing varieties of blackberries, especially Thornless Evergreen.

CONTROL: High pressure, high gallonage sprayers give best control. Use from 150 to 200 gallons of spray solution per acre. Lime sulfur (8 gallons + 92 gallons of water or a polysulfide compound, 10 lbs.+ 100 gallons of water) gives best control. A spring spray when developing lateral shoots are 2-6 inches long should be routinely used where redberry mites have been a problem. Another fall spray can be applied after old canes have been removed to clean up severe infestations. The addition of a supreme or superior oil, 1 gallon per 100 gallons of spray mixture, will help stick the sulfur to the canes in rainy spring weather. An alternate program is to make one application of sulfur dust at full bloom, 20-40 pounds per acre. Sulfur dust may cause blossoms to brown and repel bees for a day or so. Also, do not use sulfur in hot weather, burning may result.

STRAWBERRY CROWN MOTH. Larvae of this cyclic insect occasionally damage all cane berries. Damage seems to be most severe in blackcap raspberries. White larvae tunnel in larger roots and crowns. Control is the same as for the Raspberry crown borer.

THRIPS. Thrips are common flower feeders and may infest ripe berries at harvest time. If abundant at bloom, they may cause blossom blasting.

Pre-bloom sprays in infested fields are advised. Control at harvest is impractical.

LYGUS BUGS. Lygus bugs are about 3/16 inch long and have a light yellow "V" on their backs. They suck juices from berries and other plant parts with their piercing mouthparts. Occasionally lygus become so numerous at harvest that they may contaminate mechanically harvested fruit.

LOOPERS. Loopers are large green worms that move in a loopy motion and are the larbal stage of the alfalfa looper. In certain years, they may be numerous enough on the foliage of caneberries that they become a problem for mechanically harvested berries. The leaf feeding does not damage the plants, but they may contaminate machine picked fruit.

STINK BUGS. These insects serve as a source of berry contamination and are frequently seen in boxes from mechanically harvested fruit. Currently, no insecticides are registered for their control.

TREE CRICKETS. Adults lay eggs singly in the bark or cambium of various fruits trees and berries. Young crickets feed on flowers, fruit and foliage. Generally no controls are needed in fields where a good spray program is followed. Sevin is the only material labelled for their control on caneberries. Application should be timed to correspond with the appearance of the young numphs in the spring. However, Sevin is extremely toxic to bees and should not be used when bees are present in the field nor within 2 weeks of anticipated bloom.

CUTWORMS. Cutworms are very difficult to control. The larvae are most active at night, but occasionally occur on foliage on overcast mornings. The larvae of most species overwinter and mature in the spring. Adult moths deposit eggs in late May and June usually on any cover crop or weed plants present. These eggs hatch in one to two weeks and the larvae usually feed for 4 to 8 weeks. Problems may occur during the caneberry harvest. The larvae climb onto the canes, feed on the leaves and contaminate harvested fruits--particularly mechanically harvested berries. Two to four weeks prior to harvest, inspect your field very carefully for signs of cutworm problems. Very weedy fields will usually have more problems than clean cultivated fields.

YELLOW JACKETS AND WASPS. Caneberry and grape harvesting can be made much more difficult by the presence of yellow jackets, wasps and hornets. These stinging insects are all members of the genus Vespula, which are the true wasps. All are social and live either in paper nests above ground (hornets and wasps), or in cavities below ground (yellow jackets). An individual nest is initiated in the spring or early summer by a single queen wasp that overwintered. Nests are annual and seldom reused.

Adult wasps require a diet that is very high in sugar. They visit caneberry fields and vineyards in greatest numbers when overripe fruit is present. The wasps bite into the fruit to feed on the sweet juice. The adult wasps also collect protein to feed to developing larvae in the nests. They usually acquire this protein by collecting other insects. However, any available animal protein will do. This is why wasps are so often attracted to summer picnics.

SUGGESTED CONTROL MEASURES. Wasp control in caneberry fields and vineyards is best done by prevention early in the season to stop a large population of wasps from building up. Little can be done at harvest to reduce large wasp populations once they have begun to feed on ripe fruit.

Early season control may be accomplished by two methods. One is a trap baited with an attractant odor. Once the wasp enters the trap it connot escape. Depending on the type of trap, the wasp will either starve or fall into an oil solution and drown. The other method is the use of a protein bait containing a slow acting insecticide such as carbaryl (Sevin) or encapsulated diasinon. The wasps return to the nest and feed the poisoned bait to the larvae. In this manner the entire nest can be eliminated over a period of time. Both methods work best if placed around the fields in late spring or early summer when the overwintered queens are establishing nests or before new nests become heavily populated.

As mentioned, there is little a grower can do to control wasps once they have begun to enter the field. Traps may be placed around the fields but they usually are not as attractive as the ripe fruit. Homemade traps can work well. A fish, or fish head, suspended above a pan of oil at the field edge can help to prevent wasps from entering the field. Cans of fish flavored cat food, in which a suitable insecticide is mixed also work. For each can, mix either 1 teaspoon of 5% carbaryl (Sevin) dust or wettable powder or Knox Out 2 FM (encapsulated diazinon). CAUTION: Do not let pets and other animals feed on the bait! Place the bait in a cage of ½ inch wire mesh or hardware cloth so that yellow jackets enter but pets, birds, and rodents don't. Place about 2 ounces of mixed bait in a tray and place in the cage. If possible, hang cages in the shade from tree limbs or posts around the area to be protected. Best results occur when traps are placed about 100 feet apart. Replace the bait about every 2 days as it becomes unattractive to the wasps. If the wasps reappear, re-treat the area.

There are no registered insecticide sprays for use on foliage during harvest to control wasps. Even so, these sprays would provide very little control because new wasps would soon enter the fields, especially during years of high wasp populations.

The best way to control these pests is to locate individual nests. Nests can easily be eliminated with any of the commercial aerosol sprays labelled for wasp and hornet control. For aerial nests, spray the insecticide for 15 to 30 seconds into the opening at or near the bottom of the nest. For the ground nesting yellow jackets, pour a quart of gasoline or kerosine into the entrance tunnel. Do NOT light it. Gas and kerosine kill by contact and fumigation. Always apply these controls at night when all wasps are inside the nest and do not move rapidly.

PLANT DISEASES

ANTHRACNOSE. This is a fungus disease that causes severe damage on black and purple raspberries. Although also common on red raspberries, anthracnose does not seriously affect them.

Infected canes first show light grayish spots about 1/8 inch in diameter. As the disease progresses, the spots enlarge and develop purple borders and ash gray centers. Badly infected canes may be girdled or cracked.

Anthracnose sometimes attacks the leaves of raspberries but it rarely defoliates the plant. Spots about 1/16 inch in diameter appear on infected leaves. The spots have light gray centers and purple margins. Leaf tissue that is infected with anthracnose may drop out, causing holes in the leaves.

Berries on canes infected with anthracnose ripen abnormally, and fruit stems frequently are girdled.

Control-- Choose a planting site that has good air drainage. Plant anthracnose-free planting stock. After planting black raspberries, cut off the protruding canes (handles) at ground level.

Make 2 or 3 applications of fungicides as outlines in the spray schedule.

Try to make fungicide applications before anticipated periods of rainy weather, and thoroughtly cover the plants with fungicide.

After harvest, remove and burn fruiting canes and new canes that are badly infected.

Thin out healthy canes to allow good air drainage and keep rows free from weeds.

Remove wild raspberries and blackberries from fence rows and uncultivated land adjoining cultivated raspberries.

CANE BLIGHT. This is a fungus disease that enters raspberry canes only through wounds in the canes. Pruning wounds are frequently attacked by cane blight.

Dark brown cankers appear on wounds and extend down the cane or encircle it. Lateral shoots of infected fruiting canes wilt and die in warm weather. Infected canes turn grayish in summer.

CONTROL-- If possible, prune raspberries at least 3 days before an anticipated rain. Remove and burn infected canes and keep rows free from weeds.

SPUR BLIGHT. This is a fungus disease that can severely damage red raspberries in the northern part of the United States.

Brown or purple spots appear at buds along infected canes. Tissue around the buds darkens; the buds shrivel, fail to branch, and consequently do not produce fruit. Buds near ground level are affected more than buds that develop higher on the canes.

Leaves on diseased fruiting canes fall prematurely; the canes dry out and may crack.

In recent years, the disease has been of little significance in Washington.

CONTROL-- Apply sprays recommended for anthracnose. Remove and burn infected canes soon after harvest.

FRUIT ROT. Fruit rots are widespread and develop fastest on overripe and bruised raspberries.

Warm, wet weather at harvest favors the development of fruit rots.

CONTROL-- Pick only sound, firm berries and handle them carefully to avoid bruising them. Pick raspberries early in the morning when they are cool.

Store raspberries under refrigeration (32° to 40° F.) or, if refrigeration is not available, in a place that is shady and well ventilated. Fungicide sprays aid in reducing fruit rots but are no substitute for frequent, thorough pickings and careful handling.

VERTICILLIUM WILT. This is a soil-borne fungus disease that is widespread in the northern half of the United States and along the Pacific Coast and occurs on many crops. It is particularly damaging to black raspberries.

Leaves on infected fruiting canes turn yellow, gradually wither, and fall. These symptoms begin on the lower leaves and continue up the canes until the canes turn blue and gradually die.

CONTROL-- Plant wilt-free raspberries in clean soil. Rotate raspberries with other crops, but wait at least 3 years before planting raspberries in soils that have grown potatoes, tomatoes, peppers, or eggplants. Remove and burn diseased plants. Foliage applications of fungicides are ineffective for control of verticillium wilt.

MOSAIC. Raspberry mosaic, a virus disease widespread except on the Pacific Coast, causes more severe damage on black and purple raspberries than on red raspberries.

Leaves on mosaic-infected canes show large, green blisters. Leaf tissue around the blisters turns yellowish. The leaves are abnormally small and sometimes deformed. Leaves that develop in hot weather show only faint symptoms or none at all.

Mosaic also causes progressive stunting of canes. New growth from mosaic-infected raspberries is shorter than growth of preceding seasons.

On black and purple raspberries, the tips of young canes may bend, turn black and die.

varieties Canby and Washington are most susceptible, with Willamette and Puyallup being intermediate in reaction, while Sumner and Newburgh are the most resistant. From limited observations, Fairview and Meeker appear to have about the same level of resistance as Willamette and Puyallup.

Control of raspberry decline is best achieved as follows:

No planting should be made on soil that is heavy and has a tight clay subsoil, or on any soil that is poorly drained. In marginal situations select the more resistant varieties. At this time, soil fumigation for the control of raspberry decline is not recommended. Additional work is needed. Soil fumigation is recommended, however, for the control of nematode infestations and in some cases may help in the control of raspberry decline.

NEMATODES. Raspberries and blackberries are subject to attack by a number of nematode species. The most damaging types in Oregon are root rot, root lesion, and dagger nematodes. Nematode attack on plant roots often increases the severity of other soil-borne plant diseases, especially root rots and verticillium wilt.

Symptoms of nematode injury are best expressed on bearing canes. These may include weak lateral growth, small leaves, a reduction in fruit size and a tendency of the fruit to crumble when picked. Severely infected plants gradually decline in vigor. The root system may be stunted and somewhat matted, rotted or occasionally knotted (galled). The foliage may turn yellow, and early leaf drop may occur, especially during dry weather. Nematode infected plants may be more susceptible to winter injury.

CONTROL-- Nematodes will become progressively more damaging the longer raspberries and blackberries are cultivated. Periodic rotations of a wide variety of crops will help to reduce nematode population. After the canes have been destroyed, leave the soil untilled, or grow small grain for 3 or 4 years. Avoid other highly susceptible crops such as most vegetables or forage legumes.

It is necessary to obtain nematode-free planting stock. For field planting, use only planting stock that is nematode-free.

The use of nematicides in nurseries is particularly important. Chemical treatments for the control of nematodes are usually applied into the soil by injection apparatus.

On fields intednded for fruit production use DD, Telone, Vidden D or Vorles, or similar compounds for preplanting treatments. Do not use these in or around the soil of established, growing plants.

The rates of application of these chemicals vary, depending on types of formulations, uses, and methods of application. For specific dosage recommendations, follow the directions on the label.

BLACKBERRY RUST. Small yellow, powdery spots appear on the underside of leaves. Yellow pustules 1/8 to 3/8 inch long form on the canes. Chehalem and Evergreen blackberries are susceptible, Rust does not usually cause serious injury.

CANE GALL. Small, rough ridges of warty growth occur on fruiting canes. The red, black, and purple raspberry, Himalaya, boysenberry, loganberry, and youngberry are affected. Best control is by setting out disease-free plants from healthy plantings in soil free from the causal bacterium. Remove and burn severely diseased plants. Remove the contaminated soil about these plants and replace with clean soil. When the disease is not severe, but out the affected canes and burn. Avoid injury to the plants. The causal bacterium will persist in soil after the susceptible plants are removed.

CROWN GALL. Irregular, warty galls appear on the base of canes or on the roots. All cane fruits, as well as many woody shrubs and fruit trees, are affected. Follow sanitation practices as above under cane gall.

Use of a bioantagonist - - Agrobacterium radiobacter, Strain 84 (a bacterium) is preventive only. Latent infections (symptomless) or existing galls will not be controlled.

Berries on badly infected canes are dry, seedy, or crumbly, and often worthless.

CONTROL-- Plant certified raspberries that have been found to be free from the mosaic viruses, if available. Do not plant healthy raspberries near diseased plants, and do not plant red raspberries near black raspberries, even when both varieties are disease-free.

Remove and burn diseased raspberries; raspberries that leaf out late in spring are likely to be diseased. Leaf-feeding aphids spread mosaic rapidly.

Remove wild raspberries and blackberries from the vicinity of cultivated raspberries.

TOMATO RINGSPOT. Ringspot is a widespread virus disease that occurs in the major red raspberry-producing areas of the Pacific Coast. In the spring, a few leaves on infected red raspberry plants show pale green rings that disappear as canes mature. Infected plants grow slower than normal and become weak. Infected canes die back in the most susceptible varieties, or may be crumbly in other varieties. Certain varieties show no noticeable damage when infected, and are classed as tolerant.

Ringspot in red raspberry is caused by a virus first identified from tomato, and thus designated tomato ringspot virus. However, tomato ringspot virus readily infects many hosts, including weeds, and is spread through the soil by the dagger nematode.

CONTROL-- Plant stock certified to be free from tomato ringspot virus on land which is free from the dagger nematode. See section on control of nematodes.

CALICO. Calico is a virus-like disorder resulting in gradual decline of the affected plants. Although the exact cause is not known, there is evidence to indicate the disease can spread in a field. Roguing of affected plants is suggested.

RASPBERRY DECLINE. This name is used by many growers to describe a condition affecting many red raspberry plantings. Symptoms usually include wilting and marginal drying of leaves on fruiting canes and on developing young canes. Often the condition is scattered in the field, with only occasional plants at first showing the symptoms. Later it spreads down the rows and often to adjacent rows. The second year symptoms are usually more severe and the fruiting laterals are stunted and collapse before the fruit ripens. Death of canes occurs the second or third year. The roots of some affected plants are rotted either in the center or throughout. In others, little root rot is noted. Occasionaly, yellow ring spots are noted on young leaves during May and June. The final results in many fields are poor yield and death of enough plants to make continued production of questionable economic value.

Raspberry decline has been described under several names in the past including wet soil root rot, raspberry root rot, blight, and running out.

Root rots, nematodes, and one or more virus diseases may be involved in any given field. Positive diagnosis as to the exact cause is difficult. To most effectively combat this disease situation one must more carefully identify the one or more causes involved. The remainder of this discussion will outline the several specific diseases that may be responsible for this generalized condition in red raspberries.

Observations indicate that raspberry decline occurs mostly in poorly drained areas or in heavy soils with high moisture-holding capacity. The problem, however, is not limited to such conditions. While a number of fungi have been reported as possible causes of raspberry decline, Phytophthora species are most frequently found to be associated with the declining plants. These species are capable of causing severe root rot. Reports indicate that there are differences among the raspberry cultivars as to their susceptibility to wet soil root rot. The

AFFECT OF CULTURAL PRACTICES:

1. Plants on the ground are always subject to high humidity. When weeds, particularly pigweed are not controlled, the canes lie in a natural "moist chamber". Conditions are ideal for infection, and you cannot spray them effectively.

2. Trailing berries should be trellised in the summer or in late spring. Trellising canes in summer allow for better coverage from the fall spray. Canes trained after early September may be more susceptible to winter injury. Leaving the old canes during the winter provides an excellent source of infectious spores that are being constantly splashed onto the new canes on the ground. The old canes should be removed just as soon as the crop has been harvested. Canes on the ground cannot be effectively sprayed. Cones on the trellis can be much more adequately protected. Sprays, to be effective, must cover the canes--not just the tops of the remaining leaves.

3. Cold nights e.g. in February or March, may injure recently trellised canes. Cold nights often follow cold clear days. Less injury will occur if canes are trellised during mild, cloudy, or rainy days.

CONTROL:

1. Control weeds. Weeds provide a natural "moist chamber" for infection and prevent effective spray coverage.
2. Remove old canes soon after harvest.
3. Trellis canes in August, or early September, or in late spring. If you can't trellis early in the fall (this will usually be true for Evergreens) don't do it in October, wait until February or March. Evergreens however are more winter-hardy and can usually be trained safely through the winter.
4. Alternate year fruiting program. The disease has not been a problem in alternate-year (AY) producing fields when canes are trained up as they grow. If the canes are allowed to lie on the ground the leaf and cane spot problem can be just as severe as it is in fields where berries are harvested annually.
5. Spray with bordeaux 8-8-100 or Kocide 101 4 lbs. plus 1 qt. superior-type oil or fixed copper 6 lbs. (add spreader sticker)/100 gals. of water: 1) After harvest.2) After old canes have been removed. August or early

A solution of Strain 84 may be used as a dip or spray. Grafting wood, roots and crown should be thoroughly covered. Spray to run off.

Strain 84 is produced by Nortell Laboratories Inc., P.O. Box 856, Corvallis, Oregon 97330. One company in California also produces Strain 84. Both companies have EPA registration for use of their product.

Agrobacterium radiobacter 84 has successfully prevented crown gall infections on many susceptible plants grown in Oregon--species of cherry, plum, apple, pear, and caneberry (raspberry, blackberry, Boysenberry, Youngberry). For crown gall control to occur, the pathogenic strain of Agrobacterium tumefaciens which causes crown gall must be sensitive to Strain 84.

LEAF AND CANE SPOT (TRAILING BERRIES). Cause: Septoria rubi, a fungus which affects trailing berries such as Marion, Evergreen and Santiam blackberries and Boysenberry and Loganberry. In recent years, fields of Marion and Evergreen blackberries have been severely affected.

SYMPTOMS: Leafspots vary from light to dark brown. At first, they are about 1/8 inch in diameter, purplish in color and later turn brown. In older leaf spots, the centers are whitish with brown to red borders. Infections on the canes are similar to those of the leaves but may be larger blotches rather than discrete spots. Minute black fruit bodies are formed within infections. These mature and produce tiny spores. During the moist weather the spores are scattered by rain and may bring about new infections. In winter, the sexual spore stage is formed on old dead leaves and on cane infections. During the wet season in the early spring more spores are produced and these cause many new infections.

Marion and Evergreen blackberry: In late winter and spring, irregular elongated purple blotches occur on the canes. Affected areas one-half to two inches long may develop into cankers and girdle the canes. Cankers at first purple later turn black. Severely affected canes die when growth starts in the spring. Affected areas are inconspicuous on dead canes.

September training is recommended over spring training to allow better spray coverage. 3) Early October Bordeaux 8-8-100 is recommended since it resists washing by fall and winter rains.

6. Early March (when new canes 1 to 2 ft. high), spray with lime sulfur 10 gals. or fixed copper 6 lbs. per 100 gals. of spray or Kocide 101, 4 lbs. plus 1 quart superior type oil per 100 gal. of water.

7. Two weeks later; fixed copper 6 lbs. (proprietary product) or captan 50 WP, 1 1/2 lbs. or Kocide 101, 2 lbs. plus 1 quart superior -type oil per 100 gals. of water. Add spreader-sticker to all sprays--follow manufacture's directions.

8. Marion and Evergreen blackberries, in addition, should receive two to three more sprays (see 7 above) at three week intervals. Sprays applied for fruit rot control should be directed to cover the new canes as well as the fruiting canes.

RESIDUES: captan--tolerance 25 ppm. No time limitations when 3 lbs. actual or less are used per application.

coppers (fixed)--exempt.

ARMILLARIA ROOT ROT (ALL CANE BERRIES). The plants decline and dieback and eventually are killed. In the autumn honey colored mushrooms appear in crowns of plants. White, felt-like masses of fungus grow between the bark and the wood in the plant crowns. Dark brown or black thread-like strands are often found on plants at ground level or just below.

CONTROL: Remove and destroy the plants (small roots as well). Do not replant in affected spots. The fungus can live in the soil for many years.

POWDERY MILDEW (RASPBERRIES AND SOME BLACKBERRIES. The Puyallup red raspberry is very susceptible; Canby, Washington, and Willamette red raspberry and Munger black raspberry are less susceptible. Boysenberry is the most susceptible trailing berry--the fruit can be severely affected. Whitish-gray powery masses occur on leaves, fruit, young canes, fruit spurs, and buds.

STAMEN BLIGHT. CAUSE: Haplosphaeria detormans, a fungus. This disease effects Boysenberry, Youngberry, Evergreen and wild trailing blackberry.

SYMPTOMS: The organism affects the stamens of the flower and completely prevents the production of pollen. Affected stamens have a gray powdery mildew appearance. The flower pistils are not damaged. Infected flowers may actually produce fruit, providing cross-pollination occurs with healthy blossoms; but such fruits are imperfectly formed.

CONTROL: Partial control has been obtained with a lime sulfur spray at 2 gals. per 100 gals. of water applied in August. This also reduced infection the following season.

VERTICILLIUM WILT (MOST CANE BERRIES). Yellowing and wilting of foliage occur. Bluish strips of infected tissue may extend up the canes from the ground level. Himalaya, Evergreen, and wild trailing blackberries seem to be highly resistant. Plant healthy stock from disease-free plantings. Roguing and rotations of nonsusceptible grasses and cereals help. Avoid plantings where susceptible crops - - potatoes, tomatoes, eggplants, peppers, strawberries, and peaches--have been grown previously.

VIRUS DISEASES. To control virus diseases, use disease-free planting stock; rogue out and destroy suspicious or diseased plants. When more than 5 percent of the plants in the field are diseased, the value of roguing is doubtful. Do not plant red raspberry plants in soil containing the Xiphinema spp. nematode.

2. STRAWBERRIES

INSECTS AND OTHER PESTS.

ROOT WEEVILS. Several species of weevils attack strawberries. They are beetles which are characterized by having their heads elongated forward into a "snout". The adult black vine weevil is black with small yellowish spots on its back and is nearly 1/2 inch long. The strawberry root weevil and rough strawberry root weevil are similar to the black vine weevil but are all black and are only about 1/5 and 1/3 inch long, respectively. The obscure root weevil is 1/4 inch long and mostly gray with a wavy brown line across the mid-back. The woods weevil is 1/4 inch long and brown with gray spots on the back. The damage done is similar for all species. The adults do megligible damage by chewing notches in the margins of the leaves. The white larvae or grubs cause the most serious damage by feeding on the plant roots.

CONTROL-- The primary means of control of the stawberry, rough strawberry, and black vine weevils is an application of an insecticide to the soil prior to planting. Aldrin will remain effective for the life of the planting. Chlordane is effective for at least part of that period. The obscure root and woods weevils require application of insecticides to the foliage to kill adults before they lay eggs. Fields of strawberries that are badly damaged by any root weevil should be plowed deeply and fallowed, if possible, during the summer and winter if it is to be replanted to strawberries.

STRAWBERRY APHID. This insect is important mainly because it transmits several viruses on its mouth parts from diseased plants to healthy ones. It causes very little direct damage by its feeding.

CONTROL-- Application of insecticides to a new planting will not by itself prevent the introduction of viruses because the aphid can inoculate a plant before the aphid is killed. Insecticides are effective for this purpose only if all strawberry plantings within a few miles are sprayed so there are few sphids going from diseased fields to virus-free fields. Therefore, it is recommended that sprays be applied to control the strawberry aphid only if a grower's field is isolated from unsprayed fields by several miles or by an area-wide spray program. In that siuation, sprays would prevent the few aphids that might alight in the field from reproducing and thus starting an infestation that could spread viruses within the field. All fields involved would require treatment every three weeks from early April until mid September. Most commercial varieties of strawberries are sufficiently tolerant of viruses to permit satisfactory yields even when they are infected.

SHALLOT APHID. This insect can reproduce during the winter. Feeding by high populations in the spring causes severe stunting and twisting of the plants.

CONTROL-- It has not been a common problem so sprays are seldom needed.

CYCLAMEN MITE. This mite is almost invisible to the unaided eye. It feeds on the small immature leaves and causes stunting, yellowing, and twisting of the plant.

CONTROL-- The use of parathion, and possibly other insecticides, encourages increase of this mite, probably gy killing its natural control agents. The Cyclamen mite has not been common enough to warrant routine preventive sprays.

TWOSPOTTED SPIDER MITE. This mite is favored by warm, dry weather and, thus, seldom requires control before the postharvest period. It feeds on the underside of the leaves. Its presence can be detected by tiny, white spots appearing on the upper leaf surface, and severe infestations will kill the leaves.

CONTROL-- Plants can tolerate low populations of spider mites, and treatment should not be made unless needed. The exact number of mites that a strawberry plant can tolerate has not yet been determined but certainly a spray is not needed until the population reaches at least 5 mites per leaf. This mite is resistant to most chemicals in many areas. Avoid unnecessary sprays which could kill beneficial insects which give biological control. (See"When to Spray").

OMNIVOROUS LEAFEATER (STRAWBERRY FRUITWORM). Mature larvae of this moth are about 1/2 inch long. They first feed on young growing leaves which they web together. Later they bore into the ripe fruit.

CONTROL-- Best control will be obtained by applying insecticides early in the bloom period when the larvae are small.

STRAWBERRY LEAFROLLER. The larvae, which are about 1/2 inch long when mature of this moth roll and web leaves while feeding on them. It is sporadic in appearance and rarely needs treatment before harvest is completed and most years not at all. New plantings are more likely to suffer loss of vigor due to leaf damage than are established plants.

CONTROL-- Do not begin treatment on established plantings unless there are more than two larvae per plant.

SPITTLEBUGS. The eggs are laid on the strawberry plant in the summer. They hatch the following spring about the time the blossom buds appear and separate. The immature spittlebugs produce a mass of white, frothy liquid (spittle) in which they remain for protection until they reach adulthood. High populations of immature spittlebugs cause distortion of leaves and berries and reduced yields.

CONTROL-- Sprays must be timed to kill the spittlebugs shortly after hatching because the "spittle" mass protects them from the chemical.

GARDEN SYMPHYLAN. This pest is not an insect but more closely resembles the centipedes. It is white and has 6 pairs of legs after emergence from the egg but adds a pair at each of the first 6 molts so there are 12 pairs of legs at adulthood. When full grown it is about 1/4 inch long. It lives in the soil and damages plants by feeding on the roots.

CONTROL-- A preplant treatment of Dyfonate or one of the soil fumigants listed for nematode control will control it. Dyfonate will give control only during the year of establishment while fumigation, if properly done, may reduce the population so the pest is not a problem for the life of the planting. Follow manufacturers directions closely. There is currently no chemical avaialbe for treatment of established plantings.

PLANT DISEASES

FRUIT ROT. This fungus disease is very common, and can spread rapidly under moist conditions. The fungus, Botrytis cinerea, usually infects the flowers and grows into the fruit. Therefore, protective blossom sprays are important, but additional sprays may be needed during wet periods following blossoming.

CONTROL-- Varieties differ in susceptibility. Shuksan, Puget Beauty and Totem have low fruit rot incidence; Hood, Olympus and Ranier are intermediate; and Northwest and Siletz are very susceptible. Use good field sanitation. Space plants properly, control weeds, and avoid spring nitrogen application (which causes excessive foliage growth) to allow better air circulation around the fruit. Pick the fruit before it becomes overripe, and market promptly. Never place diseased berries in containers with healthy berries, especially for fresh market. Apply fungicides as recommended in the "Treatment Guide".

LEAF SPOT. This is a fungus disease which results in round, purple spots 1/8-1/4 inch in diameter on the upper leaf surfaces. Centers of the spots become nearly white, while the borders remain purple. This disease is common, especially in wet season, but is rarely serious. Northwest, Hood, and Pugent Beauty are more resistant than Shuksan, Ranier and Olympus. Ranier seems especially susceptible.

CONTROL-- Since the fungus overwinters on old, infected leaves, clip the infected foliage after harvest and remove it from the field, if practical. If possible, use furrow irrigation instead of overhead irrigation. Apply fungicides as recommended in the "Treatment Guide."

LETHAL DECLINE. The cause of this disease is not known. Young leaves are stunted and yellow, and leaflets are unequal in size. Mature leaves are drab, bronzish and cupped upward. Affected plants die. Symptoms are most noticeable from mid-May to mid-July. The disease is widespread, but not usually serious.

CONTROL-- Use certified virus-free planting stock. Remove diseased plants from the field and destroy them.

POWDERY MILDEW. This fungus disease is common and can cause some loss. Infected leaves are cupped upward, and the undersides are covered with patches of greyishwhite, powdery growth. Leaves may have purple blotches. Fruit may be infected.

CONTROL-- Varieties differ in susceptibility. Hood, Ranior, Puget Beauty, and Siletz are very susceptible. Ensure good air circulation by proper plant spacing and weed control. Since the fungus overwinters on infected plant debris, clipping and removing infected leaves from fields after harvest may be helpful. Apply fungicides as recommended in the "Treatment Guide".

RED STELE. The fungus which incites this disease is widespread, and lives in the soil. The fungus consists of different forms or races, some of which may be present in a given field, and some not. Some varieties are resistant to certain races, and not to others. The disease can be serious, and is worse in heavy, poorly drained soils. The fungus is most active during the fall, winter, and spring rainy season. The most positive symptom of this disease is the reddish-brown color of the stele(core) of diseased main roots, though stele color of diseased roots may range from pink to dark brown. Outer tissues of the affected roots remain yellowish-white, though tips of diseased roots are usually dead. Coloring of the stele may be present only near the dead tips. Roots have a rat-tail appearance because of few branch roots. These distinctive symptoms are best seen early in the growing season; they become indistinct after harvest. Because of the affected root system, the foliage in early spring is stunted, wilted, or dead. Older leaves are red, and younger leaves are blue-green.

CONTROL-- Use certified disease-free plants, and avoid planting in heavy, poorly drained areas. Varieties which have shown the greatest resistance are Olympus, Hood, Totem, and Siletz. Shuksan, Ranier, and Puget Beauty are resistant in some fields, depending on what races of the fungus are present.

ROOT KNOT NEMATODE. This nematode lives in the soil and causes swellings or galls as large as 1/4 inch in diameter and 3/8 inch in length on roots. Several short branch roots may develop just above a gall, and the tip of the root just below a gall may be hooked. Above ground, plants are off-color and lack vigor. The nematode is widely distributed, and may cause serious losses.

CONTROL-- Use certified plants free of nematodes. Nematode tests should be conducted if symptoms appear that would indicate possible nematode damage. Apply chemicals as recommended in the "Treatment Guide".

ROOT LESION NEMATODE. This nematode lives in the soil and causes brown lesions on the roots. ABove ground, affected plants appear stunted, off-color and untrifty. This damage is usually confined to several small areas withint a field. The nematode is widespread, and can cause serious losses. Legumes may harbor large populations of nematode.

CONTROL- - Use certified nematode free planting stock. Conduct nematode rests if plant symptoms indicate possible nematode damage. Apply chemicals as recommended in the "Treatment Guide".

ROOT ROTS (BLACK ROOT). There are several fungi that live in the soil which incite root rots. Root surfaces have black area, or the entire surface may be black. Initially, the outer root tissues are black and the core (stele) remains light in color. The root becomes black throughout in the final rot stages. Very few feeder roots are present. Plants are stunted, and wilt in warm weather. The disease is widespread, but serious damage is rare.

CONTROL-- Plant certified disease-free plants on fertile, well drained soil. Prevent root drying when planting, and plant at the proper depth. Avoid land with a recent history of black root rot, and where affected susceptible crops, such as cane berries, potatoes, eggplant, or pepper, have recently been grown. Rotate to grasses or cereal crops.

STEM NEMATODE. This nematode feeds on the foliage of the plant causing distortion of leaves, and shortening and thickening of petioles, fruiting branches, and runners. The general appearance of the plants is that they are stunted. The symptoms are most noticeable in the spring. The nematode is widespread, but the damage is not usually significant except during cool, wet springs on land previously planted to clover, or adjacent to clover.

CONTROL-- Use certified nematode-free planting stock. Avoid planting in or near fields where previous crops were affected, especially red clover. Rotate to new land or other crops for three years before planting strawberries again. If only a few plants are affected, remove and destroy them.

VERTICILLIUM WILT. The fungus which incites this disease is widespread and lives in the soil. It can persist at least ten years in the soil in the absence of a host plant. The older, outer leaves on affected plants wilt, turn brown at the edges and between the veins, and may cup upward along the midvein. Very few, if any, new leaves develop, and affected plants appear flattened and dry, with central leaves yellow and stunted. The plants may wilt and die suddenly. The bascular tissue of the roots, crown, and petiole bases may have brown streaks. Affected plants may occur individually, or in patches in a field. Losses from this disease can be serious.

CONTROL-- Use certified disease-free planting stock. If possible, do not plant where affected susceptible plants, such as potatoes, tomatoes, cane berries, stone fruits, eggplant, pepper, maple, and nightshade, have been grown recently. Remove and destroy infected plants. Do not replant in the infested areas.

VIRUS DISEASES (MOTTLE, CRINKLE, MILD YELLOW EDGE, AND NECROTIC SHOCK). These virus diseases are widespread, and can result in substantial crop losses. Mottle, crinkle, and mild yellow edge viruses are spread by the strawberry aphid. It is not known how the necrotic shock virus is transmitted from one plant to another. Foliage symptoms vary depending on environmental conditions, and the combination of viruses in the plant. Leaves may be streaked, yellowed, dwarfed, and cupped. Leaf petioles may be short and thick. Virus-tolerant varieties may show few, if any, obvious symptoms. Affected plants gradually decline, and severely affected plants produce few, if any, fruit.

CONTROL-- Plant virus-tolerant varieties such as Northwest, Shuksan, Olympus, Totem, Rainier, or Siletz. Use certified virus-free planting stock. Virus-sensitive varieties are Marshall, Puget Beauty, and Hood. Avoid making new plantings adjacent to old, severely infected fields. If practical, remove and destroy any affected or suspicious-looking plants. Apply insecticides for strawberry aphid as recommended in the "Treatment Guide".

TIP BURN. Tip burn is a non-infectious disorder occasionally noted in the commercial strawberry plantings. It is characterized by a necrosis or dying of the terminal portion of the strawberry leaf as it emerges from the crown. As the leaf expands it becomes puckered or distorted due to the slow growth in the injured area of the leaf tip. These symptoms have been attributed to many causes, among them boron deficiency , calcium deficiency, drought, high temperatures, nematodes, and disease pathogens. In California, tip burn is considered to be induced by unfavorable environmental conditions, principally high temperatures.

Tip burn has been noticed in greenhouses and screen houses at Mount Vernon and Puyllup for several years, notably in Marshall, Shuksan, and Olympus. In most cases the new leaves formed in late summer and early fall did not show the disorder. Vigorously growing, succulent plants are likely to develop tip burn if subjected to high temperatures when soil moisture is limited.

In the past tip burn was noted in the field in several Western Washington locations. The condition was especially severe at the Northwestern Washington Research & Extension Unit on plots of Shuksan and Olympus, in which all of the runner plants were removed several times throughout the season. Northwest and Hood plants showed some, but not severe symptoms. The condition was most severe during periods of low rainfall, long days, high temperature, and high light intensity following an extended cloudy period. Leaves which originated from the crown after the first of September were normal, and by the first of October the newly formed leaves had almost masked the condition. In a commercial field with the same varieties, less than ten miles from the Northwestern Research Unit, no tip burn symptoms were observed during the growing season.

Proof of the cause of this condition is still lacking. Our best information to date indicates that tip burn in strawberries is related to environmental stress. When the condition is of limited severity and scattered through a planting, it is not thought to be detrimental to strawberry production. However, severe symptoms would almost certainly result in less than maximum fruit production control. No remedial treatment other than maintaining adequate soil moisture and possibly a spray application of soluble boron appear to be effective in controlling the disorder. Further research is planned.

Weeds

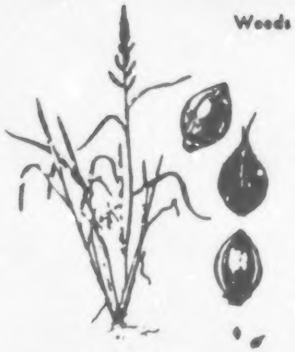
Fig. 98

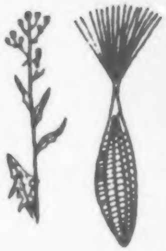
Fig. 99

Barnyard Grass (*Echinochloa crus-galli*)	Annual. Upright, coarse stem, branching from crown. Flower head rough, irregular pyramid shaped, somewhat hairy. Seeds, flat on one side, convex on other, smooth, shiny, greenish yellow. (Fig. 98)
Blue Lettuce (*Lactuca pulchella*)	Perennial. Upright, slender, round, smooth stem. Lance-shaped leaves, lower ones cut, bases of upper leaves partly clasp stem. Stem and leaves contain bitter, milky juice. Flower head branched. Blue ray flowers. Seeds flattened, club-shaped, ribbed, pappus attached. (Fig. 99)

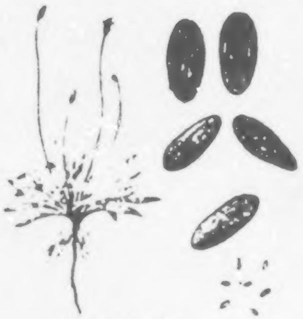
Fig. 100

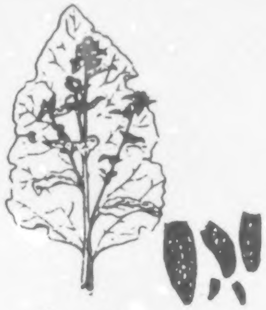
Fig. 101

Buckhorn (*Plantago lanceolata*)	Perennial. A rosette plant with slightly hairy, long, narrow leaves. Flowers and seeds in a cylindric cluster 1 to 3 inches long on a long, slender stalk arising from the midst of the rosette of leaves. Tap root. Seeds are boat-shaped, shiny brown in color. (Fig. 100)
Burdock (*Arctium minus*)	Biennial. Very large leaves growing in a cluster, resembles rhubarb. Second year, upright branched stem with smaller leaves. Purple flowers in bur-like groups. Seeds peg-shaped, dark gray. (Fig. 101)

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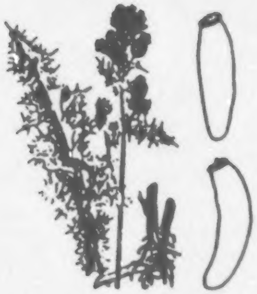
Fig. 102

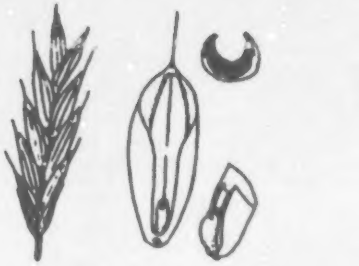
Fig. 103

Canada Thistle. (*Cirsium arvense*)	Perennial. Upright growth of deeply serrated, very spiny, crinkled leaves. No spines on small flower head. Flowers deep purple. Seeds peg-like, smooth, brown. (Fig. 102)
Cheat or Chess (*Bromus secalinus*)	Winter annual. Upright growth, resembling oats. Usually taller than the grain in which it grows. Heavy seeds cause branches to droop. Seeds about size of secondary oat kernel. Deep groove on one side of seed. (Fig. 103)

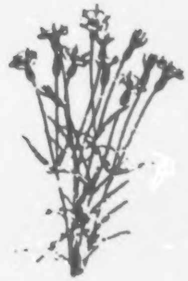
Fig. 104

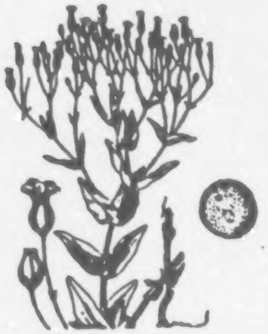
Fig. 105

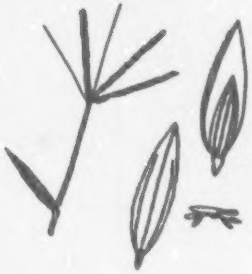
Fig. 106

Corn Cockle (*Agrostemma githago*)	Annual. Upright growth, narrow, hairy leaves, purple flower. Coarse, spiny seeds, black. (Fig. 104)
Cow Cockle (*Saponaria Vaccaria*)	Annual. Upright stem, smooth, much branched. Leaves opposite, clasping the stem. Flower head in loose clusters on long wiry stems, calyx five-ribbed, five pink petals. Seed nearly round, black color. (Fig. 105)
Crabgrass (*Digitaria sanguinalis*)	Annual. Upright, decumbent at base, many stems from crown. Flower head in many finger-like branches, becoming purple with maturity. Seed spindle-shaped. (Fig. 106)

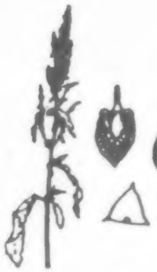

Fig. 107

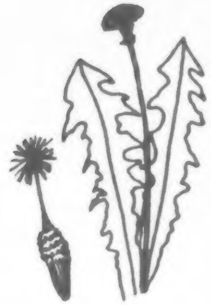

Fig. 108

Curled Dock (*Rumex crispus*)	Perennial. A rosette of leaves developing into a leafy stem, lance shaped leaves with crinkled edges. Flowers and seeds in spikes near ends of branches. Deep, yellow tap root. Seeds 3 angled, reddish brown when hulled. (Fig. 107)
Dandelion (*Taraxacum officinale*)	Perennial. Plant produces a rosette, with long, irregularly lobed and toothed leaves. Deep tap root. Flower head deep yellow. Mature seed olive drab color, spindle shaped, spiny near upper end and attached to a parachute-like structure to aid in its spread. (Fig. 108)

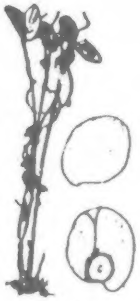

Fig. 109

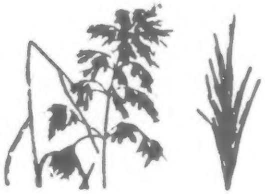

Fig. 110

Dodder, Field (*Cuscuta arvensis*, spp.)	Annual. A parasite. Yellow to orange, string-like plant branching and climbing upon host. Seeds somewhat pear shaped. Pink color, rough seed coat. (Fig. 109)
Downy Brome Grass (*Bromus tectorum*)	Annual or winter annual. Erect growth from tufted base. Leaf sheaths and blades covered with soft hairs. Flower head a panicle resembling oats. Several sterile flowers in each spikelet. Seed - see illustration. (Fig. 110)

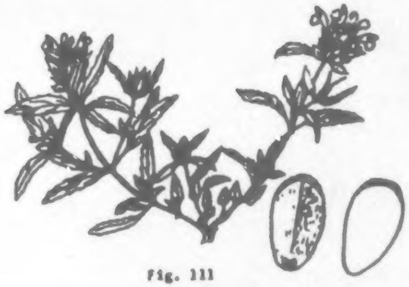

Fig. 111

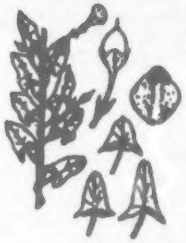

Fig. 112

Dragon-Head Mint (*Dracocephalus parviflorum*)	Annual or biennial. Erect, stout growing plant with somewhat hairy square stems, with lance-shaped or oblong leaves. Flower head usually terminal in clusters, sometimes, in upper leaf axils, flowers slight blue color. Seed oval, with two flat sides and third side rounded, black color. (Fig. 111)
Field Bindweed (*Convolvulus arvensis*)	Perennial. Vine plant with blunt pointed arrow shaped leaf. Shallow bell shaped white to pinkish white flowers, with two small bracts 1/4 to 1 inch below the flower. Four seeds borne in capsule, grayish color, slightly spiny. (Fig. 112)

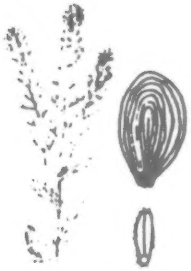

Fig. 113

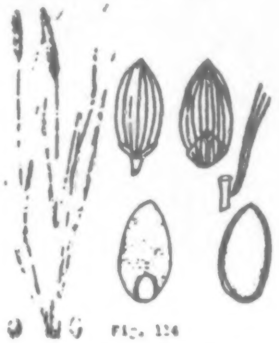

Fig. 114

Frenchweed, Fanweed or Penny cress. (*Thlaspi arvense*)	Annual or winter annual. Erect with branched stems. Flower head, white flowers and flat fan shaped pods. Seeds dark brown with eccentric ridges. (Fig. 113)
Foxtail, Green (*Setaria viridis*)	Annual. Upright in dense clumps. Flower head dense, cylindric and hairy, usually greenish becoming straw colored on ripening. Seeds resemble those of common millet except smaller, straw colored to dark brown. (Fig. 114)

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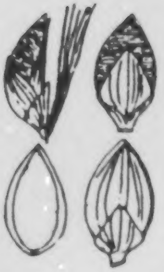

Fig. 115

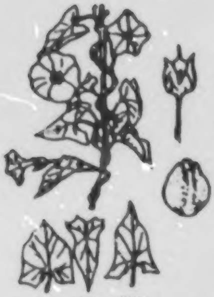

Fig. 116

Foxtail, Yellow (*Setaria lutescens*)	Annual. Resembles Green Foxtail except fewer stems, usually taller, yellowish color. Seeds similar to millet, flat or slightly concave on one side. Straw colored. (Fig. 115)
Hedge Bindweed (*Convolvulus sepium*)	Perennial. Resembles Field Bindweed except for sharp pointed, arrow shaped leaves, two large bracts at base of flower, flower deep trumpet. Seeds - smooth, black. (Fig. 116)

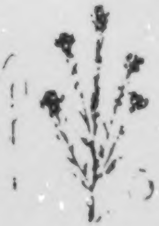

Fig. 117

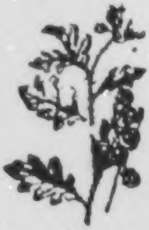

Fig. 118

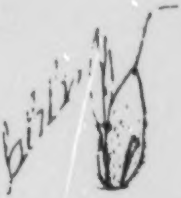

Fig. 119

Hoary Alyssum (*Berteroa incana*)	Annual or winter annual. Erect or spreading slender stem with numerous slim branches near top. Stem covered with gray-green fine, forking hairs giving the plant a grayish appearance. Leaves lance shaped. Flower head terminal. Flowers white. As plant grows, small two-celled seed pods develop. Seed flattened, brown color. (Fig. 117)
Horse Nettle (*Solanum carolinense*)	Perennial. Erect stems arise from horizontal creeping, rootstocks. Stems and leaf midribs covered with hairs and yellow spines. Violet or white flowers resembling those of the potato. Seeds borne in tomato-like berry about one-half inch in diameter. Seeds flat disk, orange color. (Fig. 118)
Johnson Grass (*Sorghum halepense*)	Perennial. Loose spreading panicle, when fully matured usually is darker in color than Sudan grass. Seeds show regular cup shaped articulation of rachillas. Creeping rootstocks. (Fig. 119)

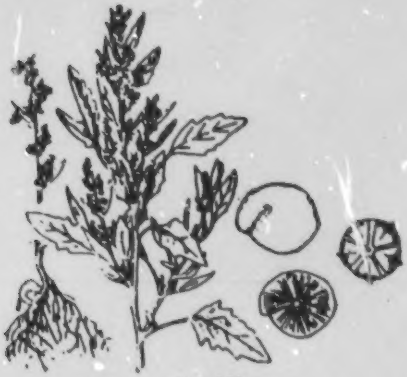

Fig. 120

Lamb's Quarters
(Chenopodium album)

Annual. Upright, slightly grooved stems. Leaves silvery green above with light silvery color on lower surface. Flowers in small groups, inconspicuous at ends of stems. Seeds lens-shaped either gray unhulled or shiny black when hulled. (Fig. 120)

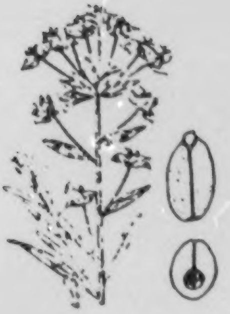

Fig. 121

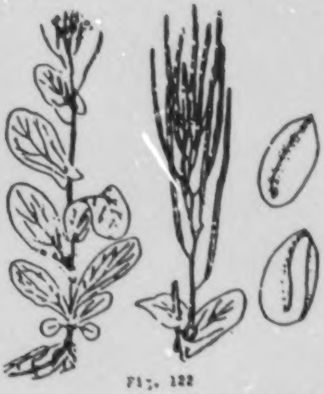

Fig. 122

Leafy Spurge
(Euphorbia esula)

Perennial. Upright, with leaves borne in whorls, flowers are in umbels, lemon yellow color. White milky juice. Seeds smooth, football shaped, gray. (Fig. 121)

Mustard Hare's Ear
(Conringia orientalis)

Annual or winter annual. Plant produces a tuft of thick, smooth leaves resembling a young cabbage plant. Flower head tall, slender erect with leaves shaped like a rabbit's ear and clasping the stem. Flowers creamy white with long, slim, square pods. Seed - oval, brown color. (Fig. 122)

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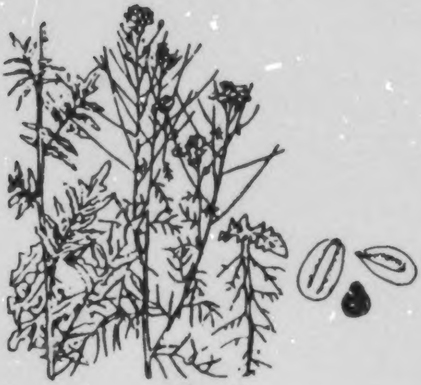

Fig. 123

Mustard, Tumbling (*Sisymbrium altissimum*)	Annual or winter annual. Upright with slender, smooth, much branched stems. Leaves cut deeply. Stem arises from a rosette with all branching near top. Flower head pale yellow on elongating racemes that develop into alternating rows of needle-like seed pods. Mature plant breaks at surface of ground below branches and tumbles over ground. (Fig. 123)

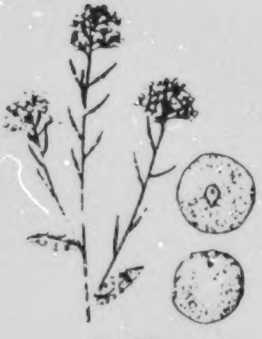

Fig. 124

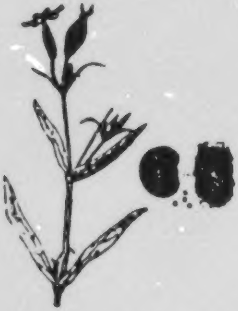

Fig. 125

Mustard, Wild (*Brassica arvensis*)	Annual. Upright, stiff, hairy leaves with irregularly cut edges. Flowers yellow. Seeds borne in spindle pod with a long beak carrying 1 to 3 seeds. Seeds round, smooth, black. (Fig. 124)
Night Flowering Catchfly (*Silene noctiflora*)	Annual. Upright, resembles White Cockle, except that seeds are borne in a 3 parted pod. See illustrations for seed characters. (Fig. 125)

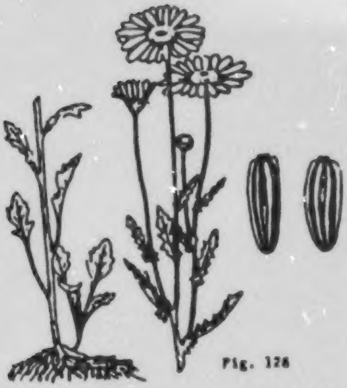

Fig. 126

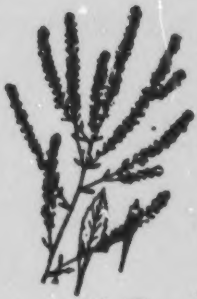

Fig. 127

Ox-eye Daisy (Chrysanthemum leucanthemum)	Perennial. Rosette plant with flower stalks arising the second year. Leaves spatulate and more or less coarsely serrated. Flowers large daisy, white rays, with yellow center. Seeds small, fluted, gray to silver color. (Fig. 126)
Peppergrass, Common (Lepidium apetalum)	Annual or winter annual. Rosette growth later becoming upright, strap-like leaves with irregular toothing. Flower head flat top, small, petals lacking. Seed pod lens-shaped, 2 seeds in a pod. Seeds flat elliptical, yellowish brown. (Fig.127)

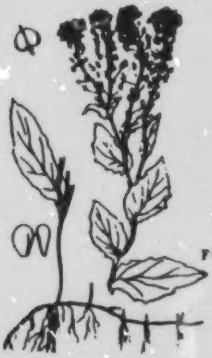

Fig. 128

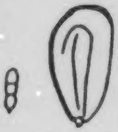

Fig. 129

Peppergrass, Perennial or Whitetop (Lepidium draba)	Perennial. Upright with short stems, many hairy, grayish leaves. Flowers white, borne in flat topped cluster. Heart shaped seed pods. Seeds almost football shaped, surface roughened, reddish brown color. (Fig. 128)
Peppergrass, Virginia (Lepidium virginicum)	Resembles Common Peppergrass except that it is larger in size. (Fig. 129)

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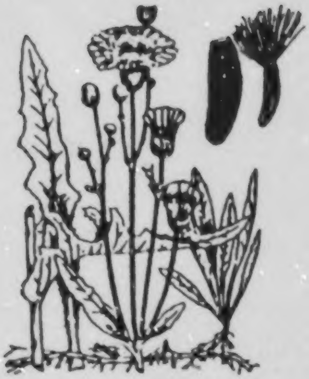

Fig. 130

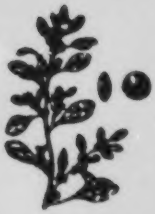

Fig. 131

Perennial Sow Thistle (*Sonchus arvensis*)	Perennial. Upright, smooth green to bluish colored, waxy, leaves with shallow to deep indentations, weak spines along leaf edge, white milky juice, bright yellow flowers resembling those of dandelion. Seeds peg-like, rough, fluted, dark brown color. (Fig. 130)
Pigweed, Prostrate (*Amaranthus biltoides*)	Annual. Prostrate green stems, frequently becoming reddish, leaves spatulate, flowers resemble those of Rough Pigweed except in smaller clusters. Hulled seeds lens-shaped, larger than those of Rough Pigweed, shiny black color. (Fig. 131)

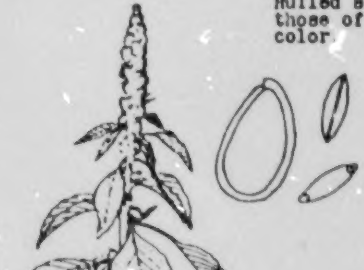

Fig. 132

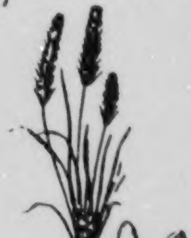

Fig. 133

Pigweed, Rough (*Amaranthus retroflexus*)	Annual. Upright, few branched, leaves diamond shaped, green stems with red roots. Flowers in compact, prickly head. Hulled seeds short elliptic, shiny black color. (Fig. 132)
Plantain, Bracted (*Plantago aristata*)	Annual or winter annual. A rosette plant, leaves narrow and more or less upright from small crown. Flowers and seeds in cylindric cluster about size of average timothy head. Tap root. Seeds are boat-shaped with groove across middle of rounded side. (Fig.133)

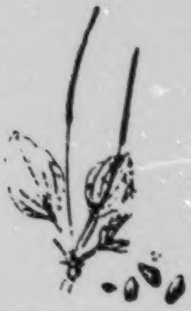

Fig. 134

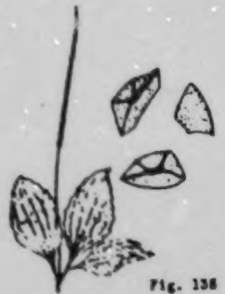

Fig. 135

Plantain, Common
(*Plantago major*)

Perennial. Similar to Rugel's except leaf stems are green, anthers of flowers are yellow. Seed pod globular, opening about middle. Seeds similar to Rugel's except amber colored with dark lines converging toward seed scar. (Fig. 134)

Plantain, Rugel's or Black Seeded
(*Plantago rugelii*)

Perennial. Rosette plant, broad leaves with prominent veins. Bases of leaves purple. Short, upright stems, fibrous roots. Flowers and seeds in a long rat-tail cluster whose stem arises from the midst of the leaves. Purple stamens. Seed pod spindle shaped, opening below middle. Seeds irregular, rounded on one side, angular on the others, black color. (Fig. 135)

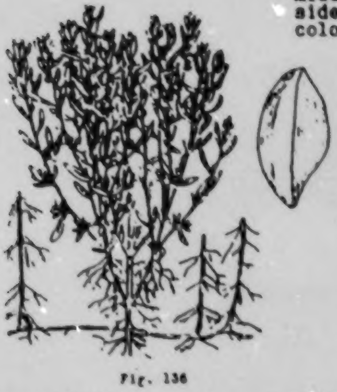

Fig. 136

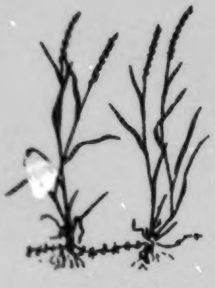

Fig. 137

Poverty Weed
(*Iva axillaris*)

Perennial. Erect growth from dense, tough, woody rootstocks. Plant has unpleasant odor. Stems diffusely branched and very leafy, rough-hairy. Flower head inconspicuous, solitary. Seed pod five-lobed. Seeds ovoid, flattened, sometimes keeled on one side, green to nearly black in color. (Fig. 136)

Quackgrass
(*Agropyron repens*)

Perennial. Stems upright, leafy, flowers on spikes like wheat. Rootstocks about size of stems, creeping habit. Five to seven florets per spikelet. (Fig. 137)

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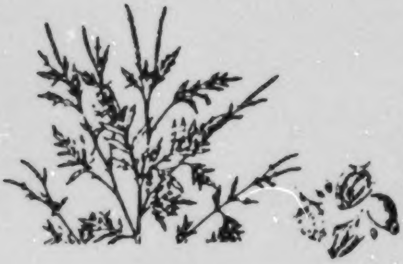


Fig. 138

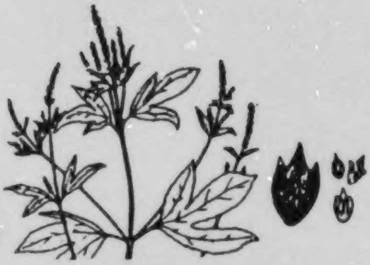


Fig. 139

Ragweed, Common (Ambrosia artemisifolia)	Annual. Upright, medium tall, alternately branched stems, hairy, finely, toothed leaves. Flowers of two kinds, male flowers on terminal branches, female flowers in axils of leaves. Seeds shaped like king's crown, gray color. (Fig. 138)
Ragweed, Greater or Kinghead (Ambrosia trifida)	Annual. Upright, very tall, resembles common ragweed except leaves are larger and broader, not so finely toothed, usually divided into three segments. (Fig. 139)

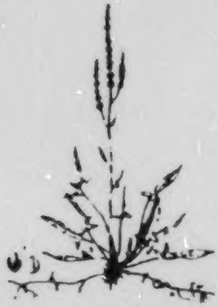


Fig. 140

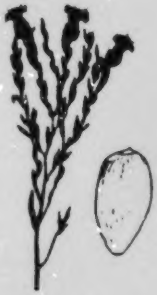
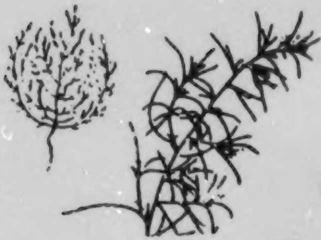


Fig. 141

Red or Sheep Sorrel (Rumex accetosella)	Dioecious, perennial. Mature plant, small upright stem, leaves halberd shaped, with sour taste. Flower stalk branched, reddish color. Horizontal roots with small laterals giving rise to new plants. Seeds 3 sided, shiny red when hulled. (Fig. 140)
Russian Knapweed (Centaura picris)	Perennial. Erect, woody stem from a tough, dark, somewhat spreading deeply penetrating root. Leaves narrow and hairy. Flower head at end of branches, pink to purple, resembling those of Bachelor Buttons. Seeds peg-shaped, bristly pappus. Seed gray color. (Fig. 141)



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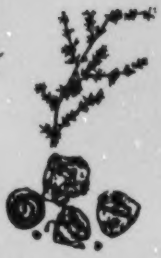

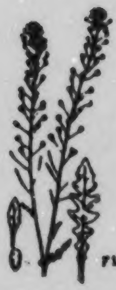

Fig. 143

Russian Thistle (Salsola pestifer)	Annual. Upright, bushy growth. First leaves produced very succulent, later leaves small, stiff and sharp pointed with 3 in a group. Flowers and seeds sessile in upper leaf axils. Seeds conical shaped, spirally ridged, gray color. (Fig. 142)
Shepherd's Purse (Capsella Bursa-pastoris)	Annual or winter annual. Resembles Common Peppergrass except flowers white, and pods are flat, triangular, with several seeds per pod. Seeds longer than thick, characteristically ridged lengthwise. Yellowish brown color. (Fig. 143)

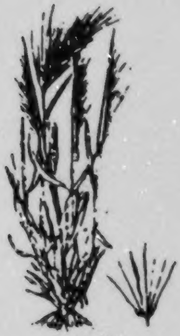

Fig. 144

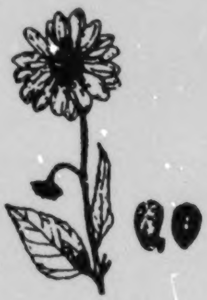

Fig. 145

Smooth Dock (Rumex mexicana)	Perennial, resembles Curled Dock except leaves are narrower and do not have crinkled edges.
Squirrel Tail Grass or Wild Barley (Hordeum jubatum)	Winter annual or biennial. Upright growth in dense bunches. Flower heads are densely awned. Head breaks into sections upon maturity. (Fig. 144)
Sunflower, Common (Helianthus annuus)	Annual. Tall erect growth, coarse rough stem, branching at the top. Flower head 3 to 6 inches broad, bright yellow with dark center. Seed large, oblong, smooth, grayish brown with white marginal stripes. (Fig.145) (Fig. 145)

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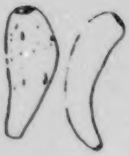

Fig. 146

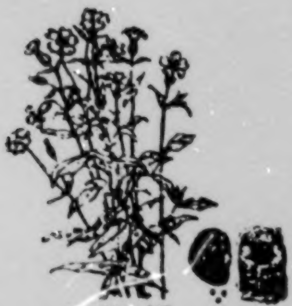

Fig. 147

Tarweed (*Madia Sativa*)	Annual upright with alternate leaves, stems one to four feet tall, covered with glands which excrete a foul smelling tar-like material. Flower heads numerous, with 8 to 12 pale yellow rays and a dark yellow center. Seeds oblong, wedge shaped and four-angled. (Fig.146)
White Cockle (*Lychnis alba*)	Perennial. Upright, hairy stem and leaves. Leaves are broad, lance shaped with three conspicuous veins. Flowers white to pinkish white. Seeds borne in 5 parted pod. Seeds kidney shaped, spiny, gray color. (Fig. 147)

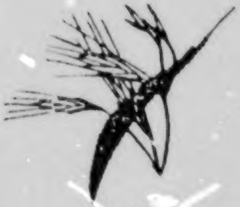

Fig. 148

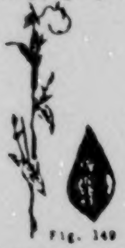

Fig. 149

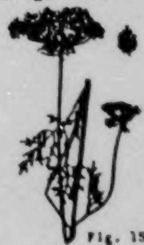

Fig. 150

Wild Brome or Ripgut Grass (*Bromus rigidus*)	Annual. Tall, erect growth from tufted branches, stems and leaves hairy. Flower head a large panicle, spikelets with stout, very long awns. Seed strong awn, rough hairy. (Fig. 148)
Wild Buckwheat (*Polygonum convolvulus*)	Annual. Twining growth, climbing on other plants, leaves arrow shaped with sharp tip and lobes at base of leaf. Stem frequently red when mature. Seeds 3 sided, brown or black color. (Fig.149)
Wild Carrot (*Daucus carota*)	Biennial or short lived perennial. Upright, more or less branching, leaves much divided resembling cultivated carrot. Flowers white in umbel; on maturing branches of umbel turn inward. Seeds flattened with 4 rows of hooked spines extending from end to end. Straw colored. (Fig. 150)

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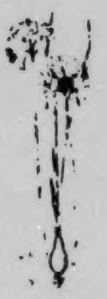

Fig. 151

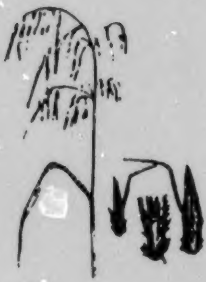

Fig. 152

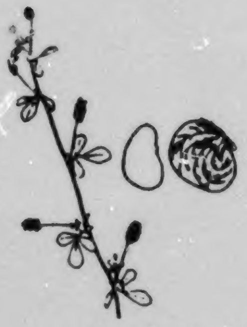

Fig. 153

Wild Garlic (*Allium vineale*)	Perennial. Resembles small onion with many small top sets. Characteristic onion odor. Bulbs serve place of seed and often are about size of wheat kernels. (Fig. 151)
Wild Oats (*Avena fatua*)	Annual. Resembles tame oats except for sucker-like depression at base of kernel, and heavy twisted awn, hairy rachilla. (Fig. 152)
Yellow Trefoil (*Medicago lupulina*)	Annual or winter annual. Prostrate, much branched, leaves resemble those of alfalfa. Flowers in small yellow clusters. Single seeded black pods. Hulled seed resembles alfalfa. (Fig. 153)

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Appendix B

COMMON RASPBERRY VARIETIES

Best Suited for Oregon

* Willamette (1942 release, Oregon-USDA). Industry standard, comprising approximately 2/3 of Washington acreage, Fruit very large, dardk red, fairly firm and suitable for processing and fresh market. Ripens early and may interfere with strawberry harvest. Shakes off mechanically when fully fipe.

Plants very vigorous and productive on good, well drained soils. Canes medium size, tall and sprawling. Laterals medium length and strong. More susceptible to freeze injury than Sumner. Susceptible to root rot.

* Meeker (1967 release, Washington). Fruit large, bridht red and firm. Escellent for processing and fresh market. Low susceptibility to Botrytis fruit rot. Harvest season 4 to 7 days later than Willamette. Very well suited to mechanical harvesting as fruit shakes off readily.

Plants are very vigorous and have been very productive on well drained soils. Canes large, tall and tending to lop over. Fruiting laterals long and fairly strong. More susceptible to freeze injury than sumner. Susceptible to root rot.

* Canby (1953 release, Oregon USDA). Berries medium to large, light red, lack firmness for processing. Harvest season early as with Willamette. Berries shake off readily for mechanical harvesting, but tend to crumble.

Plants vigorous and moderately productive on very well drained soils. Canes large, tall, straight and smooth. Ahpid immune. As winter hardy as Sumner. Plants very susceptible to root rot. Not widely grown.

* Fairview (1961 release, Oregon USDA). Berries medium to large, bright medium red, faily firm, suitable for fresh market and processing. Harvest season starts with Willamette but extends late into the season. Fruit shakes off readily for mechanical harvesting.

Plants very vigorous and productive on good soils. Canes tall, fairly striaght. Fruiting laterals very long, tending to break easily. Somewhat tolerant of heavy, poorly drained soils and some tolerance to root rot. Not widely grown.

*Best for Oregon

Other Varieties

* Sumner (1956 release, Washington). Fruit medium size, smaller than Willamette and Meeker, bright red, fairly firm, good for processing and fresh market. Harvest season 4 to 7 days later than Willamette. Not suitable for mechanical harvesting as fruit does not shake off easily.

Plants moderately vigorous. Canes medium size and striaght. Fruiting laterals medium length and strong. Tends to grow slowly the first year and does not produce the significant baby crop usually produced by Willamette. Hardiest of varieties adapted to western Washington. Most tolerant variety of heavy, poorly drained soils and thus has some root rotresistance.

Puyallup (1953 release, Washington). Fruit very large, medium red, fairly firm with large drupelets. Suitable for fresh market and processing. Harvest season 4 to 7 days later than Willamette. Fruit shakes off mechanically when ripe.

Plants vigorous and productive on well drained soils. Strong, straight canes with medium length, strong fruiting laterals. Not quite so hardy as Sumner. Susceptible to root rot and powery mildew.

Haida (1973 release, British Columbia). Presently under test in western Washington. Medium sized bright red fruit, firm, suitable for processing and fresh water. Ripens 3 to 5 days after Willamette.

Plants moderately vigorous and productive. Canes medium sized, straight and very upright. Laterals medium length and strong. Susceptible to root rot.

Susceptibility to freeze injury has not been determined under western Washington conditions.

COMMON STRAWBERRY VARIETIES

Northwest (1949 release, Washington) Mid- to late-season, standard for yield in Oregon, good runner producer, medium to large fruit of moderate firmness, conic shape, bright red, attractive, difficult to cap, very susceptible to Botrytis fruit rot, very weak cluster stem allows fruit to rest on soil surface, fruits pile on top of each other making separation and picking of ripe fruits difficult, tolerant to virus diseases, susceptible to powdery mildew, insufficient winter hardiness. Good for frozen slice pack but not so good as Hood for preserves, not so suitable as other varieties for fresh fruit marketing.

Shuksan (1970 release, Washington) Same season as Northwest. Very good runner producer, fruit larger and firmer than Northwest, broad wedge conic shape, some primary fruits furrowed, bright red, glossy and attractive, difficult to cap, long, weak fruit clusters allow ripe fruit to rest on soil surface, low susceptibility to Botrytis fruit rot, tolerant to virus diseases and to some races of the red stele root rot fungus, moderate susceptibility to powdery mildew, very good winter hardiness, generally equal to Northwest for freezing, but with greater firmness, suitable for fresh fruit marketing because of tough skin and firmness.

Hood (1965 release, Oregon USDA) Four days earlier than Northwest, yield nearly equal to Northwest throughout Western Oregon, very good runner producer, fruit larger and firmer than Northwest, broad round conic, bright red, glossy and attractive, easy to cap, upright fruit cluster holds fruit off soil surface, good fruit accessibility for picking, moderate susceptibility to Botrytis fruit rot, susceptible to virus diseases, tolerant to several races of the red stele root rot fungus, resistant to powdery mildew, intermediate level of winter hardiness, poor texture for freezing but very good for preserve manufacture, suitable for fresh fruit marketing.

Puget Beauty (1956 release, Washington) Seven days earlier than Northwest, much below Northwest in yield, good runner producer, fruit medium in size and smaller than Northwest, fruit long conic, slightly necked, glossy, bright red, only moderate firmness, easy to cap, upright fruit cluster holds fruit off soil surface, low susceptibility to Botrytis fruit rot, very susceptible to virus diseases and to most races of the red stele root rot fungus, resistant to powdery mildew, intermediate level of winter hardiness, poor texture and color for freezing, suitable for early fresh fruit marketing.

Olympus (1973 release, Washington) Same season as Northwest. Very shy runner producer, fruit comparable to Northwest in size and firmness, short conic shape, bright red with sunken seeds and tender skin, moderate susceptibility to Botrytis fruit rot, very easy to cap, reflex calyx suitable for machine capping, long arching fruit cluster with ripe fruit resting on soil surface, tolerant to virus diseases and to several races of the red stele root rot fungus, susceptible to powdery mildew, winter hardiness has not been determind, equal to Northwest in processing quality, not suited for fresh fruit marketing.

Ranier (1972 release, Washington) Three days later than Northwest, moderate runner producer, fruit larger than Northwest in size, and slightly firmer, uniform wedge conic shape, bright red, very attractive, extremely difficult to cap, long, weak fruit cluster with fruit resting on soil surface, moderate susceptibility to Botrytis fruit rot, tolerant to virus diseases and some races of the red stele root rot fungus, resistant to powdery mildew, intermediate level of winter hardiness, excellent for frozen pack and preserves, very well suited for fresh fruit marketing.

COMMON BLACKBERRY VARIETIES

Boysen, a California introduction, is widely grown, quite vigorous, and productive. The fruit is dark red, quite large, and ripens from early July to late August. It is used on the local market and for freezing and canning. The flavor is excellent, being subacid to acid.

Cascade is an Oregon introduction, vigorous and productive. The berries are dark red, smaller than Logan, somewhat soft and not the best-suited for fresh market. Cascade ripens at the same time as Logan, has a characteristic wild blackberry flavor, and is well suited to home-garden culture. Canes grow like the wild blackberry, small in diameter.

Chehalem is an Oregon introduction, quite vigorous, with long canes, and highly productive. Berries are bright black but rather small. Flavor is excellent and seeds are small. This berry is frozen and used for pies. It ripens a few days later than Boysen.

Thornless Evergreen, an Oregon introduction, is a sport of Evergreen, and because of its ease of handling has replaced this variety. Fruit is firm and has a fair flavor. Large quanities are canned. This berry is very productive and accounts for the largest acreage of all blackberry varieties raised in Oregon. It ripens in August and September. It is hard to get pickers for the late part of the crop, causing a growing interest in mechanical pickers.

Logan is a California berry, quite vigorous and productive when well cared for. Berries are dark red, of medium size, and tend to be a little soft. An acid type berry, with desirable flavor, it is grown mainly for juice and wine It ripens from late June through July.

Marion is an Oregon introduction which produces only a few large canes. It is very productive on long laterals. Berries are medium to large, bright black, and of excellent flavor. It is used for canning, freezing, and the fresh market.

Nectar is a California origin and appears to be quite similar to Boysen.

Pacific is of Oregon origin, much like Cascade except it has less vigor and is less productive. Fruit is slightly larger, firmer, and possibly more acid than Cascade.

Appendix C

STRAWBERRIES

36 inches between rows:

18 inches between plants -- 9680 plants per acre
24 inches between plants -- 7260 plants per acre
30 inches between plants -- 5808 plants per acre
36 inches between plants -- 4833 plants per acre

RASPBERRIES

2-½ feet x 7 feet--2489 plants
2-½ feet x 8 feet--2178 plants
2-½ feet x 9 feet--1936 plants
2-½ feet x 10 feet--1742 plants

3 feet x 7 feet--2074 plants
3 feet x 8 feet--1815 plants
3 feet x 9 feet--1613 plants
3 feet x 10 feet--1452 plants

TRAILING TYPE BERRIES

Distance between plants (feet)	Distance between rows (feet)	Number of plants per acre
8	8	680
8	9	600
9	9	538
9	10	484

Grower's Spray Record

Date Applied	Crop Treated	Stage of Growth	Field Identification	Pest Controlled	Chemical Used	Rate Used	Remarks (Weather, Dates, Etc.)

AgIII-XII-64

Appendix D

Appendix E

SPRAY CALIBRATION

It is essential that growers check their sprayer output at least once per season and preferably before applying herbicides.

You must know

1. how many gallons of spray are being delivered in the area sprayed; and
2. how many acres you can cover with one filling of your spray tank; and
3. how much chemical to put in your spray tank.

The follow is a suggested method:

a. Adjust nozzle arrangement and boom height to obtain uniform spray pattern on the soil surface area to be sprayed. Avoid overlapping spray patterns.

b. Choose the desired tractor speed the throttle settings to be used both in the trial and during the spray operation.

c. Adjust pump to desired pressure, usually 30 to 50 pounds per square inch.

d. Fill tank completely full with water only.

e. Measure and spray a 1,000-foot-long strip, using the tractor speed, throttle-setting, and pressure decided upon in (b) and (c) above. The 1,000-foot-test strip may be on a roadway, but would preferably be in the crop to be sprayed, so that all necessary boom adjustments may be done when spraying water only.

f. Refill tank completely, measuring accurately the number of gallons of water needed to refill the tank.

g. Note the total width of the sprayed pattern, the width of the band sprayed, and the row spacing.

EXAMPLE 1

We wish to apply a recommended chemical at 3 pounds per total acre to a strawberry planting, where the rows are 48 inches apart. We wish to spray a band 24 inches wide over the center of each row. The total width of the spray pattern was 12 feet. It took 5 gallons to refill the tank after spraying the 1,000-foot test-strip.

We know

Area per acre = 43,500 square feet
Length of test strip = 1,000 feet
Width of sprayed strip = 12 feet
Distance between rows - 48 inches
Width of band sprayed - 24 inches
Water needed to refill tank (used in test-strip) = 5 gallons
Capacity of your spray tank = 120 gallons
Amount of chemical recommended per total acre = 3*

Formula 1: to find gallons of spray delivered per total acre.

$$\frac{\text{43,560 sq. ft X 5 gal.}}{\text{1,000 ft. X 12 ft.}} = \text{18 gal. per ac.}$$

Formula 2: To find how many acres may be covered with one full tank.

$$\frac{\text{120 - gal. tank}}{\text{18 gal. per ac.}} = \text{6.6 ac. per tank}$$

Formula 3: To find how much chemical to put in the spray tank.

$$\frac{\text{3 lb. X 6.6 ac. X 24}}{\text{48 in.}} = \text{9.9 lb.}$$

Alternate to Formula 3: Refer to extension bulletin for amounts to use when spraying rows only.

If the total area and not just the rows are to be sprayed, the spray booms should be adjusted to cover the total soil surface. When the acreage is determined at the completion of Formula 2, it is a simple matter to multiply this figure by the recommended amount of chemical per total acre.

(e.g., in the above example)
6.6 ac. X 3 lb./ac. = 19.8 lb. for your spray tank.

EXAMPLE 2

We wish to apply the recommended chemical at 1 gallon per acre and another at 3 pounds per acre to a raspberry planting where the rows are 10 feet apart. We wish to spray a band 18 inches wide along the sides of each row. The combined spray pattern is, therefore, 3 feet wide. It took 3 gallons to refill the tank after spraying 1,000 feet of rows.

Formula 1:

$$\frac{43{,}560 \text{ sq. ft} \times 3 \text{ gal.}}{1{,}000 \text{ ft.} \times 10 \text{ ft.}} = 13.0 \text{ gal. per ac.}$$

Formula 2:

$$\frac{120\text{-gal. tank}}{13 \text{ gal. per ac.}} = 9.2 \text{ ac. per tank}$$

Knowing it will apply 13.0 gals. per acre, you can go to the extension bulletin and mix the appropriate amount of pesticide to achieve desired results.

You may adjust gallons per acre by reducing tractor speed or by increasing tank pressure.

*Pounds per acre are available through extension bulletins or field man.

AgIII-XII-68

Appendix F

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Oregon State University Fertilizer Guide for

Extension Service, Oregon State University, Henry A. Wadsworth, director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Extension invites participation in its programs and offers them equally to all people.

FG 48
Revised November 1977

Loganberries, Boysenberries, and Marion Blackberries

(Western Oregon-West of Cascades)

Loganberries, Boysenberries, and Marion blackberries are among several types and varieties of caneberries grown in western Oregon. Fruit is produced on current season fruiting clusters which develop from canes produced the previous year. Canes that have produced a berry crop are normally removed after harvest before the new canes are trained and pruned. Root systems are perennial.

Good fertilizer usage helps produce profitable crops of these caneberries. However, fertilizer is no substitute for good management such as selection of adapted caneberry soils and sites; use of high quality plants; disease and insect control; shallow cultivation; weed control; rodent control, particularly for field mice; and timely harvest. After harvest, irrigation improves yields in most fields.

Recommendations are based on a row spacing of 10' (3 m) with plants spaced 5-6' (1.5-1.8 m) apart in the rows.

Soil tests should be used as a guide to good fertilizer practice.

Follow recommended soil sampling procedures to insure satisfactory fertilizer recommendation. Your county agent can provide you with instructions on correct soil sampling.

Soil samples should be taken at least 6-9 months before new fields are planted in the spring. This will permit application of lime, if necessary, before planting.

NITROGEN (N)

Less N is needed during the planting year than in fields 2 or more years old. In new fields, apply the N in continuous bands shortly after setting the plants. Band N on both sides of the row, 4-6" (10-15 cm) to the side taking care not to disturb recently set plants. N can be banded with phosphorus (P) and/or potassium (K).

N may be banded in late winter or early spring of the second growing season. Bands should be placed at the edge of the root zone.

Losses of N from surface band applications of urea can occur where the fertilizer is not washed into the soil by rain or irrigation soon after application.

By the start of the third growing season, most growers prefer to broadcast N and other fertilizers. Surface banding may be satisfactory, but continuous banding of N can cause detrimental acidification in the band.

N recommendations are:

	Apply this amount N	
	lb/A	kg/ha
Planting year	30-40	35-45
Feb.-Mar., 2nd year	40-60*	45-65*
Feb.-Mar., 3rd year	60-70	65-80

*Maximum N for established Boysenberries is 50 lbs/A (56 kg/ha).

PHOSPHORUS (P)

P moves very slowly in the soil. *Band placement in the root zone gives most efficient results from P.*

In new fields, P is usually banded with N or N and potassium (K). Place bands 4-6" (10-15 cm) to the side of the caneberry rows and 4-6" (10-15 cm) deep.

If equipment is available, P should be banded into the soil in the second and succeeding years. Place P bands at the edge of the root zone or no deeper than the depth of cultivation.

If the OSU soil test for P reads (ppm):	Apply this amount P_2O_5	
	lbs/A	kg/ha
0 - 30	100-120	110-135
30 - 50	80-100	90-110
50 - 75	60- 80	65- 90
Over 75	None	

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

POTASSIUM (K)

K is needed in relatively large amounts of these caneberries. There appears to be some correlation between adequate K levels and firm berries.

In new fields, K may be broadcast and mixed with the soil before planting. This is particularly desirable if the potassium application exceeds 60 lbs/A (65 kg/ha) K_2O.

A split application of K may also be used in new fields, if the application exceeds 60 lbs/A (65 kg/ha) K_2O.

From 1/2 to 2/3 of the K application can be broadcast and mixed before planting and the remaining 1/2 to 1/3 can be banded with N and P after planting. No more than 40-60 lbs/A (45-65 kg/ha) K_2O should be included in an N-P-K mixture banded after planting. Excessive amounts of banded K may cause burning of new feeder roots, particularly in sandy soils.

In fields two years old or older, K can either be banded or broadcast, alone or in combination with N, P, and possibly other fertilizers.

If the OSU soil test for K reads (ppm):	Apply this amount K_2O lbs/A	kg/ha
75 - 150	80-100	90-110
150 - 250	60- 80	65- 90
250 - 400	40- 60	45- 65
Over 400	None	

The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by 0.83 to convert to K.

SULFUR (S)

Dormant sprays of lime-sulfur or calcium polysulphide compounds supply enough sulfur for these caneberries. If S sprays are not used, the fertilizer program should include 20 lbs/A (22 kg/ha) S each year.

Several fertilizer materials used to supply other nutrients also contain S.

MAGNESIUM (Mg)

The Mg requirements of these caneberries are unknown. Trial applications of 15 to 20 lbs/A (17-22 kg/ha) Mg banded after planting are suggested when the soil test value for Mg is below 1.5 meq Mg/100g of soil. The Mg can be mixed with other fertilizer elements.

Both Mg and calcium can also be supplied in dolomite lime. Dolomite should be worked into the field before planting (preferably the previous summer, fall, or earlier) at 1 to 1.5 T/A (2-3.5 Tm/ha).

BORON (B)

These caneberries need B in very small quantities. B is extremely important for normal development of flowers and berries. *Plants are very sensitive to excess B.*

B should either be broadcast, boom sprayed, or applied as a foliar spray. *It should not be banded*, particularly in new fields. It can be custom mixed with other fertilizer or added to most of the sprays recommended for caneberries.

If the OSU soil test for B reads (ppm):	Apply this amount of B lb/A	kg/ha
Under 0.50	2-2.5*	2 -3*
0.50-1.00	1.5-2*	1.5-2*
1.00-1.50	1	1.0
Over 1.50	None	

*One year only. Follow with 1-1.5 lb/A (1-1.5 kg/ha) B/year, starting next year.

LIME

Loganberries, Boysenberries, and Marion blackberries are moderately tolerant to soil acidity.

Lime applications are suggested when the soil pH is 5.5 or below, or when calcium (Ca) levels are below 5 meq Ca/100g of soil. However, if total bases exceed 20 meq/100g on fine textured (clayey) valley floor soils, lime is probably not needed unless the pH is below 5.2.

The rate of lime application can be estimated from the following OSU SMP buffer table.

If the OSU SMP buffer test for lime reads:	Apply this amount of lime T/A	Tm/ha
Below 5.2	4-5	9-11
5.2-5.6	3-4	7- 9
5.6-5.9	2-3	4- 7
5.9-6.2	1-2	2- 4

The liming rate is based on 100-score dry lime.

Lime should be mixed into the soil at least several weeks before planting. A lime application is effective over several years.

Some soils may have a fairly high OSU SMP buffer value (over 6.5) and a low pH (below 5.5). This condition can be caused by the application of acidifying fertilizer. In this case the low pH value is temporary and the pH of the soil will increase as the fertilizer completes its reaction with the soil. This temporary "active" acidity from fertilizer is encountered following recent applications of most N fertilizer materials. Acidifying fertilizers also have a "long term" acidifying effect on soil which is cumulative and leads to lower OSU SMP buffer readings.

Sandy soils to which fertilizers have not been recently applied sometimes record low pH and high SMP buffer values. In such cases, a light application of 1-2 T/A (2-4 Tm/ha) of lime should suffice to neutralize soil acidity.

For acid soils low in Mg (less than 0.8 meq Mg/100g of soil) 1 T/A (2 Tm/ha) of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

Fertilizer Guide #3, "Liming Materials for Oregon," which is available from your local OSU Extension Office, provides additional information on lime.

CONVERSION TO METRIC UNITS

In this FG, English and metric units are used. The abbreviations and Conversion Factors (C.F.) are:

From	To	C.F.
Feet (')	Meters (m)	0.305
Inches (")	Centimeters (cm)	2.54
Pounds (lb)	Kilograms (kg)	0.454
Acres (A)	Hectares (ha)	0.405
Tons (T)	Metric tons (Tm)	0.907
Pounds per Acre (lb/A)	Kilograms per Hectare (kg/ha)	1.12
Tons per Acre (T/A)	Metric Tons per Hectare (Tm/ha)	2.24

The suggested P, K, Mg, B, and lime applications are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Arden Sheets, Ken Brown, and Hugh Gardner, Cooperative Extension Service; and L. W. Martin, North Willamette Experiment Station, all Oregon State University. Reviewed by a committee of western Oregon county Extension agents.

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Oregon State University Fertilizer Guide for

Extension Service, Oregon State University, Henry A. Wadsworth, director. This publication was produced and distributed in further
ance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the
U.S. Department of Agriculture, and Oregon counties. Extension invites participation in its programs and offers them equally to all people.

FG 51
Revised May 1979

Thornless Evergreen Blackberries

(Western Oregon - West of Cascades)

The Thornless Evergreen Blackberry is the most vigorous and highest yielding "Tame Blackberry" variety grown in western Oregon. Highest yields are produced in irrigated fields.

The Thornless Evergreen Blackberry was selected from wild, thorny plants. Inherent thorniness remains in the roots even though the canes are thornless. Since root injury results in thorny canes, management practices should include shallow cultivation, elimination of grape hoes, and a program for control of field mice, moles, and gophers.

Good fertilizer usage helps produce profitable crops of these caneberries. However, fertilizer is no substitute for good management such as selection of adapted caneberry soils and sites; use of high quality plants; disease and insect control; weed control, and timely harvest.

Recommendations are based on a row spacing of 10' (3 m) with plants spaced 5-6' (1.5-1.8 m) apart in rows.

Soil tests should be used as a guide to good fertilizer practice. Follow recommended soil sampling procedures to insure satisfactory fertilizer recommendation. Your county agent can provide you with instructions on correct soil sampling.

Soil samples should be taken at least 6-9 months before new fields are planted in the spring. This will permit application of lime, if necessary, before planting.

NITROGEN (N)

Irrigated Thornless Evergreen Blackberries will respond to a higher rate of N than any other caneberry type or variety grown in western Oregon.

Less N is needed during the planting year than in fields 2 or more years old. In new fields, apply the N in continuous bands shortly after setting the plants. Band N 4-6" (10-15 cm) from both sides of the row. N can be banded with phosphorus (P) and potassium (K).

N should be banded in late winter or early spring of the second growing season. The second pair of bands should be placed at the edge of the root zone.

Losses of N from surface band applications of urea can occur where the fertilizer is not washed into the soil by rain or irrigation soon after application.

By the start of the third growing season, most growers prefer to broadcast N and other fertilizers. Surface banding may be satisfactory, but continuous banding of N can cause detrimental acidification in the band.

N recommendations are:

	Apply this amount N	
	(lbs/A)	(kg/ha)
Planting year	40- 60	45- 65
Feb.-Mar., 2nd year	60- 80	65- 90
Feb.-Mar., 3rd year	80-100*	90-110*
4 years or older	80-120	90-135

*Maximum N for non-irrigated fields

PHOSPHORUS (P)

Band placement in the root zone gives most efficient results from P as P has little movement in the soil.

In new fields, P is usually banded with N, or N and K. Place bands 4-6" (10-15 cm) to the side of the caneberry rows and 4-6" deep.

If equipment is available, P should be banded into the soil in the second and succeeding years. Place P bands midway between rows no deeper than the depth of cultivation.

If the OSU soil test for P reads (ppm):	Apply this amount P_2O_5 lbs/A	kg/ha
0 - 15	100-120	110-135
15 - 30	80-100	90-110
30 - 50	60- 80	65- 90
Over 50	None	

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

POTASSIUM (K)

K is needed in relatively large amounts by these caneberries.

In new fields, K may be broadcast and mixed with the soil before planting. This is particularly desirable if the K application exceeds 90 lbs/A (100 kg/ha) K_2O.

A split application of K may also be used in new fields, if the application exceeds 90 lbs K/A.

From 1/2 to 2/3 of the K application can be broadcast and mixed before planting and the remaining 1/2 to 1/3 can be banded with N and P after planting. No more than 40-60 lbs/A (45-65 kg/ha) K_2O should be included in an N-P-K mixture banded after planting. Excessive amounts of banded K may cause burning of new feeder roots, particularly in sandy soils.

In fields two years or older, K can either be banded or broadcast, alone or in combination with

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N, P, and possibly other fertilizers.

If the OSU soil test for K reads (ppm):	Apply this amount K_2O (lbs/A)	(kg/ha)
0 to 100	100-120	110-135
100 to 225	80-100	90-110
225 to 350	60- 80	65- 90
Over 350	None	

The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by 0.83 to convert to K.

SULFUR (S)

Dormant sprays of lime-sulfur or calcium polysulphide compounds supply enough sulfur for these caneberries. If S sprays are not used, the fertilizer program should include 20 lbs/A (22 kg/ha) S each year.

Several fertilizer materials used to supply other nutrients also contain S.

MAGNESIUM (Mg)

The Mg requirements of these caneberries are unknown. Trial applications of 15 to 20 lbs/A (17-22 kg/ha) Mg banded after planting are suggested when the soil test value for Mg is below 1.5 meq Mg/100g of soil. The Mg can be mixed with other fertilizer elements.

Both Mg and calcium can also be supplied in dolomite lime. Dolomite should be worked into the field before planting (preferably the previous summer, fall or earlier) at 1 to 1.5 T/A (2-3.5 Tm/ha).

BORON (B)

These caneberries need B in very small quantities. B is extremely important for normal development of flowers and berries. *Plants are very sensitive to excess B.*

B should either be broadcast, boom sprayed, or applied as a foliar spray. *It should not be banded*, particularly in new fields. It can be custom mixed with other fertilizer or added to most of the sprays recommended for caneberries.

If the OSU soil test for B reads (ppm):	Apply this amount of B (lbs/A)	(kg/ha)
Under 0.50	2 -2.5*	2 -3*
0.50-1.00	1.5-2*	1.5-2*
1.00-1.50	1	1.0
Over 1.50	None	

*One year only. Follow with 1-1.5 lb/A (1-1.5 kg/ha) B/year, starting next year.

LIME

These caneberries are moderately tolerant to soil acidity.

Lime applications are suggested when the soil pH is 5.5 or below, or when calcium (Ca) levels are below 5 meq Ca/100g of soil. However, if total bases exceed 20 meq/100g on fine textured (clayey) valley floor soils, lime is probably not needed unless the pH is below 5.2.

The rate of lime application can be estimated from the following OSU SMP buffer table.

If the OSU SMP buffer test for lime reads:	Apply this amount of lime (T/A)	(Tm/ha)
Below 5.2	4-5	9-11
5.2-5.6	3-4	7- 9
5.6-5.9	2-3	4- 7
5.9-6.2	1-2	2- 4

The liming rate is based on 100-score dry lime.

Lime should be mixed into the soil at least several weeks before planting. A lime application is effective over several years.

Some soils may have a fairly high OSU SMP buffer value (over 6.5) and a low pH (below 5.5). This condition can be caused by the application of acidifying fertilizer. In this case the low pH value is temporary and the pH of the soil will increase as the fertilizer completes its reaction with the soil. This temporary "active" acidity from fertilizer is encountered following recent applications of most N fertilizer materials. Acidifying fertilizers also have a "long term" acidifying effect on soil which is cumulative and leads to lower OSU SMP buffer readings.

Sandy soils to which fertilizers have not been recently applied sometimes record low pH and high SMP buffer values. In such cases, a light application of 1-2 T/A (2-4 Tm/ha) of lime should suffice to neutralize soil acidity.

For acid soils low in Mg (less than 0.8 meq Mg/100g of soil) 1 T/A (2 Tm/ha) of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

Fertilizer Guide #3, "Liming Materials for Oregon", which is available from your local OSU Extension Office, provides additional information on lime.

CONVERSION TO METRIC UNITS

In this FG, English and metric units are used. The abbreviations and Conversion Factors (C.F.) are:

From	To	C.F.
Feet (')	Meters (m)	0.305
Inches (")	Centimeters (cm)	2.54
Pounds (lb)	Kilograms (kg)	0.454
Acres (A)	Hectares (ha)	0.405
Tons (T)	Metric tons (Tm)	0.907
Pounds per Acre (lb/A)	Kilograms per Hectare (kg/ha)	1.12
Tons per Acre (T/A)	Metric Tons per Hectare (Tm/ha)	2.24

The suggested P, K, Mg, B, and lime applications are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Arden Sheets, Ken Brown, and Hugh Gardner, Extension Service, Oregon State University. Reviewed by a committee of western Oregon county Extension agents.

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AgIII-XII-72

Oregon State University Fertilizer Guide for

BLACK RASPBERRIES
(Blackcaps)
(Western Oregon - West of Cascades)

FG 50
Reprinted November 1972

Blackcaps are one of several types of caneberries grown in western Oregon.

The fruit is produced from shoots that grew the previous summer. Canes that have produced a crop are removed after harvest and new canes may be immediately trained or can be pruned and trained the following February or March.

The root stock is perennial and capable of producing fruiting canes for a number of years.

Proper fertility is important in the production of profitable crops but is only one of many factors involved. Deep, well drained soils are essential. Other management practices include the use of high quality plants; accepted training practices; effective disease, insect, and weed control; the avoidance of deep cultivation; and the following of other generally accepted practices.

Blackcaps are grown on both dry and irrigated lands, but irrigation usually results in considerably increased yields.

Fertilizer recommendations are based on plantings in which the rows are 9 to 10 feet apart and the plants spaced 2 1/2 feet to 3 feet apart in the row. If distance between plants in the row is greater, the fertilizer rate may be reduced accordingly.

Soil samples should be taken the year previous to planting and should be the basis for fertilizer applications.

NITROGEN (N)

In new fields apply N in continuous bands shortly after setting the plants. Band N on both sides of the row, 4-6 inches to the side. N can be banded with P and/or K. On established plantings, the past season's growth can be an aid in determining the amount of N to apply. November to February applications have been most effective on established plantings.

On established plantings N can be banded at the edge of the root zone or broadcast over the surface. Root pruning should be avoided when fertilizers are banded.

N recommendations are:

	Apply this amount of N (lb/A)
Planting year	20-40
Established planting	30-60

When a heavy sod crop has been plowed under prior to planting, the initial N application should be doubled.

PHOSPHORUS (P)

Blackcaps have shown a marked response to P in soils testing low in P.

Band placement of P is most effective in new plantings. Band P on both sides of the row. Band should be 4 to 6 inches to the side of the row and 4 inches deep.

On established plantings, if equipment is available, P should be banded into the soil when it is required. Place P bands at the edge of the root zone or no deeper than the depth of cultivation.

If OSU soil test for P reads (ppm)	Band this amount (lb/A) P_2O_5	P
0-20	80-100	35-44
20-40	60- 80	26-35
40-80	40- 60	18-26
Over 80	none	

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

POTASSIUM (K)

Blackcaps respond markedly to K if the soil test for K is low. In new fields, K should be broadcast and mixed with the soil before planting.

A split K application should be used if over 80 lbs K_2O/A is recommended. At least 50 per cent of the K should be broadcast before planting and the remainder should be banded with N and P after planting.

Cooperative Extension work in Agriculture and Home Economics, Lee Kolmer, director. Oregon State University and the United States Department of Agriculture cooperating. Printed and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

In established plantings K should be banded or broadcast, alone or in combination with N, P, and possibly other fertilizers.

If OSU soil test for K reads (ppm):	Apply this amount (lb/A) K_2O	K
0-150	60-100	50-83
150-250	40- 60	33-50
250-350	30- 40	25-33
Over 350	none	

The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by 0.83 to convert to K.

SULFUR (S)

Dormant sprays of lime-sulfur normally supply enough S; also S is contained in some N and P and K fertilizers.

MAGNESIUM (Mg)

With new plantings, if the pH of the soil is below 5.4 and soil test value for Mg is below 1.5 meq/100g soil, apply 1 ton/A of dolomite lime prior to planting and work into the soil. Dolomite lime is an effective liming material and is equal to ground limestone in reducing soil acidity.

With established plantings applications of 15 to 20 lbs Mg/A, usually applied in the form of potassium magnesium sulfate banded after planting are recommended when the Mg soil test value is below 1.5 meq Mg/100g soil.

BORON (B)

Blackcaps require B in very small quantities but are *very sensitive to excess B*. Too much B can be as harmful as too little.

B should be either broadcast, boom sprayed, or applied as a foliar spray. *B should not be banded.*

If OSU soil test for B reads (ppm):	Apply this amount of B (lbs/A):
Below 0.50	2*
0.50-1.50	1-2
Over 1.50	none

*This is for one year only. Apply 1 - 1 1/4 lbs B/A per year thereafter. This application may be omitted the last year of the planting.

LIME

Blackcaps are moderately tolerant to soil acidity.

Liming is recommended when the pH of the soil is below 5.4

Using the SMP lime requirement soil test, apply sufficient lime to raise the soil to pH 5.6.

Lime is most effective when applied the year before planting and worked into the soil.

A lime application is effective over several years.

Dolomite is an effective liming material and can be used where Mg is deficient.

The use of nearly all N fertilizers increases soil acidity and thereby increases the need for lime.

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The P, K, Mg, B and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

The recommendations are largely based on experience in growers' fields.

Prepared by Ralph Garren, Palmer S. Torvend, R. L. Smith, and Hugh Gardner, Cooperative Extension Service; Oregon State University. Reviewed by a committee of Western Oregon County Extension Agents.

AgIII-XII-74

COOPERATIVE EXTENSION SERVICE
OREGON STATE UNIVERSITY

Oregon State University Fertilizer Guide for

FG 49
Reprinted April 1976

RED RASPBERRIES

(Western Oregon - West of Cascades)

Good fertilizer usage helps produce profitable crops of raspberries. However, fertilizer is no substitute for good management. Other management practices include selection of adapted well drained soils and sites; use of high quality certified plants; disease and insect control; shallow cultivation; weed control including use of recommended chemicals; rodent control, particularly for field mice; and timely harvest. Irrigation improves yields in most fields.

Water levels in the soil during the winter should not be closer than 2' to the surface even for a few days

Soil tests should be used as a guide to good fertilizer practice.

Follow recommended soil sampling procedures to insure satisfactory fertilizer recommendation. Your County Agent can provide you with instructions on correct soil sampling.

NITROGEN (N)

Some red raspberry varieties are more vigorous than others and may require less N to give the desired amount of cane growth. Growers are advised to pay special attention to the amount of cane growth. Annual application of N should be reduced when there is too much cane growth. More N will increase growth where needed.

In new fields, apply the N in continuous bands 4-6 inches on both sides of the row shortly after planting. N can be banded with P and/or K.

N may be banded in late winter or early spring of the second and succeeding growing seasons. Bands should be top dressed or placed just below the soil surface in order to avoid root pruning.

N guides are:

	Apply this amount N (lb/A):
Planting year	40-60
Feb.-Mar., 2nd year or older	60-80

PHOSPHORUS (P)

Band placement in the root zone gives most efficient results from P.

In new fields, P is usually banded with N, or N and K. Place bands 4-6 inches to the side of the caneberry rows and 4-6 inches deep.

On established planting place P bands at the edge of the root zone and no deeper than the depth of cultivation.

If the OSU soil test for P reads (ppm):	Apply this amount (lb/A) P_2O_5
0 to 20	100-120
20 to 40	80-100
40 to 60	60-80
over 60	none*

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

*Apply the least rate (above) next year, in February or March.

POTASSIUM (K)

K is needed in relatively large amounts by raspberries.

In new fields, K may be broadcast and plowed down before planting.

A split application with 1/2 to 1/3 of K being plowed down before planting should be used in new fields if the recommendation exceeds 90 lbs K_2O/A. The remaining K should be banded with N and P after planting. Excessive amounts may cause burning of new feeder roots. This burning is accentuated in sandy or dry soils.

In fields two years old or older, K can either be banded or broadcast, alone or in combination with N, P, and possibly other fertilizers.

If the OSU soil test for K reads (ppm):	Apply this amount (lb/A) K_2O
75 to 150	80-100
150 to 250	60- 80
250 to 350	40- 60
over 350	none*

The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by .083 to convert to K.

*Apply the least rate (above) next year, in February or March.

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Extension Service, Oregon State University, Corvallis, Joseph R. Cox, director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U. S. Department of Agriculture, and Oregon counties.

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SULFUR (S)

Dormant sprays of lime-sulfur or other calcium polysulphide compounds supply enough sulfur for raspberries.

MAGNESIUM (Mg)

The specific Mg requirements for red raspberries are unknown. Applications of 15 to 20 lbs Mg/A banded after planting are suggested when the soil test value for Mg is below 0.8 meq Mg/100g soil. The Mg can be mixed with other fertilizer elements.

Both Mg and calcium are supplied in dolomite lime. Dolomite should be worked into the field before planting (preferably the previous summer, fall, or earlier) at 1 to 1 1/2 T/A.

BORON (B)

Red raspberries need B in very small quantities as it is important for normal development of flowers and berries. As plants are very sensitive to excess B, too much can be just as harmful as too little.

B should either be broadcast, boom sprayed, or applied as a foliar spray. It should not be banded. It can be added to most of the sprays—particularly Bordeaux mixture.

If the OSU soil test for B reads (ppm):	Apply this amount of B (lb/A)
Under 0.50	2*
0.50-1.50	1-2
Over 1.50	None

*One year only. Follow with 1 lb B/A the next year.

LIME

Raspberries are moderately tolerant to soil acidity.

Lime applications are suggested when the soil pH is 5.5 or below, or when calcium (Ca) levels are below 5 meq Ca/100g of soil.

If the OSU buffer test for lime reads:	Apply this amount of lime (T/A):
Below 5.2	4-5
5.2-5.6	3-4
5.6-5.9	2-3
5.9-6.2	1-2

The liming rate is based on 100-score lime.

Lime is most effective when applied well in advance of planting and worked into the soil.

A lime application is effective over several years.

The use of nearly all N fertilizers increases soil acidity and thereby increases the need for lime.

Evaluate the soil acidity problem when making new plantings. The lime application should allow for some decrease in soil pH during the life of the planting.

For soils needing lime which are low in Mg (less than 0.8 meq Mg/100 g of soil) one ton /A of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

Fertilizer Guide #3, Liming Materials for Oregon, which is available from your local OSU Extension Office, provides additional information on lime.

MANURE

Manures contain variable amounts of all plant nutrients. All of the nutrients in manure are not completely available the first year. The following table gives the approximate average content of some nutrients in fresh manures:

Nutrient Content of Manures

Kind of Manure	Nutrient & Water Content %			
	Water	N[1]	P_2O_5	K_2O
Dairy	87	0.5	0.16	0.44
Beef	82	0.65	0.43	0.53
Poultry	73	1.30	1.02	0.50
Hog	84	0.45	0.27	0.40
Sheep	73	1.00	0.36	1.00
Horse	60	0.70	0.25	0.60

[1] About 50% of the N is available the first year.

Losses of N sometimes exceeding 50% can occur during manure storage or following application to the surface of soil. N loss is least when fresh manure is spread and worked into the soil immediately.

Further information on manure is available from your County Extension Office.

The P, K, Mg, B, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Ralph Garren Jr., J. P. Sprowls, E. Hugh Gardner, and Lloyd Martin, Extension Service and Agricultural Experiment Station, Oregon State University. Reviewed by a committee of Western Oregon County Extension Agents.

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Oregon State University Fertilizer Guide for

FG 14
Revised November 1973

Strawberries

(Western Oregon-West of Cascades)

Good management is essential if optimum fertilizer responses are to be realized. These management practices include use of *recommended varieties* and *disease-free plants*; selection of *adapted soils* and sites; *disease* and *insect control*; *weed control*; and *irrigation*.

It is of particular importance that the soil be sampled and tested before the establishment of a new planting.

After harvest, fertilizer applications are recommended for established strawberry plantings.

With irrigation, apply fertilizer about August 1 and follow with irrigation.

Without irrigation, apply fertilizer about August 1 or within one month after harvest is completed.

Follow recommended soil sampling procedures to insure satisfactory fertilizer recommendation. Your county agent can provide you with instructions on correct soil sampling.

NITROGEN (N)

1. Apply 30 to 40 lbs N/A at planting time. Double this rate of N when a heavy sod crop or straw has just been turned under.
2. Apply another 30 to 40 lbs N/A in mid-July to mid-August of the planting year. In bearing fields (irrigated), apply 30 to 50 lbs N/A about August 1.

Without irrigation—10 lbs N/A applied as a urea spray may aid N utilization. The urea solution should not contain more than 45 lbs of urea (46% N) per 100 gals. water.

Spring applications of N on bearing fields are recommended only when plants have suffered from winter injury. Apply 15 to 20 lbs N/A.

PHOSPHORUS (P)

Strawberries have shown marked response to P on some soils.

P fertilizer should be banded on both sides of the row. Bands should be 3 to 4 inches from plants and 4 to 6 inches deep when planting or at the edge of the row when rows are trimmed following harvest.

At planting or in August on established stands:

If OSU soil test for P reads (ppm):	Band this amount of phosphorus (P_2O_5)-(lbs/A):
0 to 15	100-120
15 to 45	60-100
over 45	40- 60

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

POTASSIUM (K)

For new plantings rates of K_2O up to 60 lbs/A should be banded with N and P after planting. Any K_2O above the 60 lbs/A rate should either be broadcast or banded or side dressed no later than August. Some growers prefer to broadcast all of the K prior to planting.

If OSU soil test for K reads (ppm):	Apply this amount of potassium (K_2O)-(lbs/A):
Below 75	100-120
75-175	80-100
over 175	40- 80

The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by 0.83 to convert to K.

SULFUR (S)

The fertilizer program should include an annual application of at least 15 to 20 lbs S/A. S is contained in some fertilizer materials used to supply the other nutrients and in fungicides such as sulfur sprays or dusts.

MAGNESIUM (Mg)

Applications of Mg are suggested when Mg soil test values are below 1.0 me Mg/100g.

Mg can be supplied in dolomite which is a liming material and reduces soil acidity to about the

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same degree as ground limestone.

BORON (B)

B should be broadcast and worked into the soil prior to planting.

B or borated fertilizer should never be banded.

If OSU soil test for B reads (ppm):	Apply this amount of B (lbs/A):
Below 0.5	1.5-2
0.5 to 1.0	1-1.5

With a soil test value below 1 ppm B, an annual maintenance application of 1 lb actual B/A should be broadcast or applied as a foliar spray.

LIME

Strawberries are fairly tolerant of soil acidity and have a comparatively low lime requirement.

If the soil pH is below 5.4 and calcium (Ca) is less than 5 me/100g, an application of 1 to 1.5 T/A lime or dolomite lime may be desireable.

Lime or dolomite lime should be applied a year or more before planting and worked into the soil. Lime should not be applied directly to existing strawberry fields.

If recent lime or dolomite applications have been made, the K application should be increased by 60 to 90 lbs K_2O/A.

P, K, Lime, B and Mg recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by R. Garren, Horticulture, L. W. Martin, North Willamette Experiment Station; and Hugh Gardner and T. L. Jackson, Soil Science; Cooperative Extension Service and Agricultural Experiment Station, Oregon State University. Reviewed by a committee of Western Oregon County Extension Agents.

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AgIII-XII-78

Appendix G

Oregon State University

BOYSENBERRIES
Enterprise Data Sheet

Cooperative Extension Service

Based On:
1. 7 irrigated acres, 100 acre farm (3/4 acre for headlands)
2. Yield: Year 1 0 lbs.
   Year 2 1,500 lbs.
   Year 3 3,000 lbs.
   Years 4-10 7,000 lbs.
3. Hired labor at $2.00/hr.
4. Owner's labor at $3.00/hr.
5. 35 HP tractor @ $2.50/hr.
6. 480 plants/acre.

	INPUTS PER ACRE					
	Labor			Other		Total
ESTABLISHMENT: Years 1 and 2	Hrs.	Value	MACH.	Qty.	Value	Cost
Cultural operations 1/						
Plow	1.0	3.00	3.25			6.25
Disc and harrow (3X)	1.5	4.50	4.85			9.35
Lay out field (2 men)	1.0	2.50		Mtl.	1.00	3.50
Plant (4 men)	12.0	24.00*		plants	80.00	104.00
Hand fertilize (3 men)	1.0	2.35*	.90	Mtl.	8.00	11.25
Lay canes in row	5.0	10.00*				10.00
Cultivate (10X)	5.0	15.00	15.00			30.00
Irrigate (4X, 6" total)	3.0	6.00*	6.00	elect.	4.00	16.00
Put in posts (200)				posts	140.00	
Dig holes @ 10¢				custom	20.00	
Put in posts @ 15¢				custom	30.00	
String, tighten, and staple wire (2 men)	4.0	10.00		wire etc	25.00	225.00
Train canes (baby crop)	12.0	24.00				24.00
Dormant and spring sprays				custom	20.00	20.00
Pre-harvest cultivate (6X)	3.0	9.00	9.00			18.00
Fertilize	1.0	3.00	3.00	Mtl.	12.00	18.00
Irrigate (4X, 6" total)	3.0	6.00*	6.00	elect.	4.00	16.00
Train canes in row	12.0	24.00*		pins	1.00	25.00
Remove old canes	10.0	20.00*				20.00
Harvest Baby Crop						
Picking labor (6¢/lb)		90.00*				90.00
Other harvest exp. (supervision, hauling, etc; 1½¢/lb)		17.00*	4.50	supply	1.00	22.50
Other Charges						
Interest on land inves. 2/	$800/A, @ 7%				124.00	124.00
Taxes on land 2/	$ 15/A, 2 yrs.				33.25	33.25
Interest on operating capital	8½%				42.40	42.40
General overhead 3/					26.90	26.90
Total cash costs		220.35	21.00		413.90	655.25
Total non-cash costs		50.00	31.50		158.65	240.15
Total costs (cash and non-cash)		270.35	52.50		572.55	895.40
Credit for baby crop, 1500 lbs. @ 18¢/lb						(270.00)
Net establishment costs						625.40
Amortization of establishment costs, 7% for 8 yrs. (.1675)						104.7

- See Reverse Side -

BOYSENBERRIES

	INPUTS PER ACRE					
	Labor			Other		Total
PRODUCING: Years 3-10	Hrs.	Value	MACH.	Qty.	Value	Cost
Cultural operations 1/						
Fall-winter herbicide spray				custom	8.00	8.00
Train canes	50.0	100.00*				100.00
Fall fungicide	1.0	3.00	3.00	Mtl.	6.00	12.00
Dormant lime sulfur	1.0	3.00	3.00	Mtl.	7.50	13.50
Cane borer drench	1.0	3.00	3.00	Mtl.	8.00	14.00
Fruit worm spray	1.0	3.00	3.00	Mtl.	3.50	9.50
Cultivate (9X)	4.5	13.50	13.50			27.00
Train canes in row	30.0	60.00*				60.00
Hoeing	7.0	14.00*				14.00
Irrigate (3X, 6" total)	3.0	6.00*	6.00	elect.	4.00	16.00
Remove old canes	35.0	70.00*				70.00
Harvest costs (3 ton ave.)						
Picking labor (6¢/lb)		360.00*				360.00
Other harvest exp. (supervision, hauling, etc; 1½¢/lb)		70.00*	15.00	supply	5.00	90.00
Other charges						
Interest on land investment 2/	$800/A	@ 7%			62.00	62.00
Taxes on land 2/	$15/A				16.60	16.60
Interest on operating capital 8½%					13.00	13.00
General overhead 3/					16.50	16.50
Total cash costs		680.00	18.60		73.35	771.95
Total non-cash costs		25.50	27.90		76.75	130.15
Total costs (cash and non-cash)		705.50	46.50		150.10	902.10
Amortization of establishment (front page)						104.75
Total cost including amortized establishment						1,006.85
Cost/lb at 2 ton yield						21.4¢
Cost/lb at 3 ton yield						16.8¢
Cost/lb at 4 ton yield						14.5¢

These data were obtained and computed by County Agent Don Rasmussen and Farm Management Technologist Stanley Miles in cooperation with Marion County berry growers in February, 1971.

* Primarily hired labor

1/ Consult your county agent for recommendations on specific cultural practices.

2/ Taxes and interest included for headland and road area.

3/ Approximately 5% of cash costs excluding harvest expenses.

AgIII-XII-80

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STRAWBERRIES

Based on:
1. 20 ac. on a 200 ac. farm
2. 3 bearing yrs., 4 ton/ac. average
3. Operator's labor, $8/hr. 1/
4. Hired labor, $5/hr. 1/
5. Tractors:
   90-100 HP $12/hr.
   50 HP $ 6/hr.
   25 HP $ 3/hr.

INPUTS PER ACRE

PRODUCING YEARS	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Pre-Harvest Cultural Operations						
Cultivate (3X)	3.0	24.00	12.00			36.00
Hoeing	8.0	40.00				40.00
Insecticide & fungicide spray or dust (3X)	1.0	8.00	9.00	mtl.	40.00	57.00
Irrigation (2X, 2" ea.)	2.0	10.00	20.00	Elec.	3.50	33.50
Harvest Costs						
Picking & supervision labor (14¢/lb.)		1120.00				1120.00
Hauling (1¢/lb.)		40.00	40.00			80.00
Bookkeeping, recruiting, etc.		80.00		Supplies	9.00	89.00
Post-harvest Operations						
Irrigation (2X, 2" ea.)	2.0	10.00	20.00	Elec.	3.50	33.50
Clip tops	.33	2.65	4.60			7.25
Weevil control (banded)	.2	1.60	1.80	mtl.	18.00	21.40
Cultivate & runner control (2X)	2.0	16.00	10.00			26.00
Subsoil	.5	4.00	6.75			10.75
Herbicide	.2	1.60	1.80	mtl.	6.00	9.40
Side dress fertilizer 2/				Fert.	47.00	47.00
Other Charges						
Land charges, including taxes					150.00	150.00
Operating capital interest (11%)					18.00	18.00
General overhead					15.00	15.00
Cash Costs		1180.00	50.40		153.50	1383.90
Non-Cash Costs		177.85	75.55		156.50	409.90
TOTAL ANNUAL PRODUCTION COSTS		1357.85	125.95		310.00	1793.80
Amortized establishment cost (back page)						480.00
Credit for post-harvest practices not incurred in last year						(46.90)
Net cost/producing year						2226.90
Cost/lb. @ 6 ton yield						23.6¢
Cost/lb. @ 5 ton yield						25.3¢
Cost/lb. @ 4 ton yield						27.8¢
Cost/lb. @ 3 ton yield						32.1¢

(Footnotes on back of page)

These data were obtained and compiled by County Agent Arden Sheets and Extension Economist Stanley Miles in cooperation with Washington County growers.

Department of Agricultural and Resource Economics, February 1979.

INPUTS PER ACRE

ESTABLISHMENT YEAR	Labor		Machinery	Other		Total cost
	Hrs.	Value	Machinery	Item	Value	Total cost
		($)	($)		($)	($)
Cultural Operations						
Subsoil	.5	4.00	6.75			10.75
Plow	.4	3.20	7.20			10.40
Disc and harrow (3X)	.75	6.00	13.50			19.50
Field cultivator (2X)	.5	4.00	8.00			12.00
Fumigation 2/	.5	4.00	6.00	mtl.	140.00	150.00
Cultimulcher (2X)	.33	2.65	5.95			8.60
Fertilize (broadcast)	.17	.85	1.20	fert.	15.00	17.05
Preplant insecticide	.2	1.60	1.80	mtl.	43.00	46.40
Lime (2 ton) 2/				custom	50.00	50.00
Plant trimming	3.0	15.00				15.00
Planting, 11,000 plants/ac. 5 people (5 ac. in 8 hours)	8.0	44.80	14.40	Plants	385.00	444.20
Roll plants	.2	1.00	2.60			3.60
Fertilize 3/				Fert.	47.00	47.00
Herbicide	.2	1.60	1.80	mtl.	45.00	48.40
Irrigation (3X, 6" total)	3.0	15.00	60.00	Elect.	6.00	81.00
Cultivate (3X)	3.0	24.00	12.00			36.00
Herbicide (fall)	.2	1.60	1.80	mtl.	20.00	23.40
Hand weeding, crew	8.0	40.00				40.00
Pest control	.2	1.60	1.80	mtl.	14.00	17.40
Other Charges						
Land charge (cash rent basis)					150.00	150.00
Operating capital interest (11%)					45.60	45.60
General overhead					36.50	36.50
Total Cash Costs		103.85	58.00		816.00	977.85
Total Non-Cash Costs		67.05	86.80		181.10	334.95
Total Establishment Costs		170.90	144.80		997.10	1312.80
Amortized for 3 years at 10%						480.00

1/ Includes Social Security, Workman's Compensation, and other labor expenses.

2/ Generally done but not required in all cases.

3/ Applied during another operation and includes soil insecticide.

AgIII-XII-82

OREGON STATE UNIVERSITY
EXTENSION SERVICE

BLACK RASPBERRIES

Based on:
1. 40 ac. (irrig.) on a 200 ac. diversified farm
2. Yield: Yr. 1 0 lbs.
   Yr. 2 2,000 lbs.
   Yr. 3-7 3,000 lbs.
3. Machine Harvester, $40/hr.
4. Tractors used:
   90-100 HP @ $12/hr.
   50 HP @ 6/hr.
   25 HP @ 3/hr.
5. Operator's labor 7.50/hr.1/
6. Hired labor 5.00/hr.1/

	INPUTS PER ACRE					
	Labor			Other		Total Cost
PRODUCING YEARS: YEARS 3-7	Hrs.	Value $	Mach. $	Item	Value $	$
CULTURAL OPERATIONS						
Clip laterals (winter)	1.0	7.50	8.00			15.50
Dormant spray	.5	3.75	4.50	mtl.	9.00	17.25
Cover sprays (4X, fungicide, and insecticide)			air 18.00	mtl.	25.00	43.00
Hoeing	5.0	25.00				25.00
Herbicide spray	.3	2.25	1.50	mtl.	26.00	29.75
Fertilize 3/	.5	2.50	2.00	fert.	32.00	36.50
Disc & rotovate (2X)	1.0	7.50	13.00			20.50
Irrigation (4X, 2" ea.)	4.0	20.00	150.00	elect.	8.00	178.00
Top green shoots (2-3X)	40.0	200.00				200.00
Plant cover crop	.5	3.75	2.50	seed	3.00	9.25
Fall copper spray	.5	3.75	4.50	mtl.	15.00	23.25
Crown bore drench (3 people)	3.0	17.50	4.00	mtl.	13.00	34.50
HARVEST COSTS						
Machine picking (3X, 7 people) 3¢/lb.	21.0	112.50	120.00			232.50
Haul. & other harvest exp., 3¢/lb.		30.00	30.00	sup.	30.00	90.00
OTHER CHARGES						
Int. on land investment, $2500/ac. @ 10% 4/					250.00	250.00
Taxes on land					15.00	15.00
Int. on operating capital, 11%					26.00	26.00
General overhead 5/					27.00	27.00
Cash costs		377.50	154.00		203.00	734.50
Non-cash costs		58.50	204.00		276.00	538.50
Total cost each production year		436.00	358.00		479.00	1,273.00
Plus amortized establishment costs						415.00
Total cost, inc. amortized estab.						1,688.00
Cost per lb. @ 1500#/ac.						104.4¢
Cost per lb. @ 3000#/ac.						56.3¢
Cost per lb. @ 4500#/ac.						40.2¢
Cost per lb. @ 6000#/ac.						32.2¢

(Footnotes on back of page)

These data were obtained and compiled by County Agent Arden Sheets and Extension Economist Stanley Miles, in cooperation with Washington County growers.

Department of Agricultural & Resource Economics, February 1979

AgIII-XII-83

ESTABLISHMENT: Years 1 and 2	Labor		Machinery	Other		Total cost
	Hrs.	Value ($)	($)	Item	Value ($)	($)
Cultural Operations						
Soil test				OSU	20.00	20.00
Lime (2 ton)				custom	50.00	50.00
Subsoil (2X)	.7	5.25	9.45			14.70
Plow	.5	3.75	9.00			12.75
Preplant soil insecticide	.3	2.25	2.70	mtl.	40.00	44.95
Disc and harrow (3X)	.6	3.00	10.80			13.80
Fumigation (2 people) 2/	1.5	9.40	8.00	mtl.	140.00	157.40
Roll	.7	3.50	9.10			12.60
Field cultivation (2X)	.4	2.00	6.40			8.40
Plant, 3' X 9' (5 people)	6.0	33.00	11.25	plants	240.00	284.25
Fertilize 3/	.5	2.50	2.00	fert.	32.00	36.50
Herbicide (2X)	.6	4.50	3.60	mtl.	21.00	29.10
Irrigate (1X-1")	1.0	5.00	30.00	elect.	1.00	36.00
Replant (10%)	3.0	15.00		plants	25.00	40.00
Cultivate 3X	3.0	22.50	12.00			34.50
Hand weeding	3.0	15.00				15.00
Irrigation (3X, 2" ea.)	3.0	15.00	120.00	elect.	6.00	141.00
Between row cultivation (4X)	2.0	10.00	14.00			24.00
Topping new shoots (2-3X)	2.5	12.50				12.50
Plant cover crop (year 1)	.5	3.75	2.50	seed	3.00	9.25
Clip laterals (spring)	12.0	60.00				60.00
Dormant spray	.5	3.75	4.50	mtl.	9.00	17.25
Herbicide (spring)	.3	2.25	1.50	mtl.	26.00	29.75
Fertilize 3/	.5	3.75	2.00	mtl.	32.00	37.75
Top green shoots	15.0	75.00				75.00
Irrigation (4X, 2"ea.)	4.0	20.00	150.00	elect.	8.00	178.00
Insecticide spray (3X)	1.0	7.50	6.00	mtl.	16.50	30.00
Rotovate	1.5	7.50	10.50			18.00
Plant cover crop (year 2)	.5	3.75	2.50	seed	3.00	9.25
Harvest Baby Crop						
Picking labor, 30¢/lb.		600.00				600.00
Other harvest expenses 5¢/lb.		50.00	25.00		25.00	100.00
Other Charges						
Interest on land investment, $2500/ac. @ 10%, 2 yrs. 4/					500.00	500.00
Taxes on land (FUV) $15/yr., 2 years					30.00	30.00
Interest on operating capital 11%					170.00	170.00
General overhead 5/					77.00	77.00
Total Cash Costs		898.75	182.80		849.50	1931.05
Non-Cash Costs		102.65	270.00		625.00	997.65
Total Establishment Costs		1001.40	452.80		1474.50	2928.70
Total Establishment Costs						2928.70
Credit for baby crop, 2000 lbs. @ 60¢						1200.00
Net Establishment Costs						1728.70
Amortized establishment costs (5 years @ 10%)						415.00

1/ Includes social security, workman's comp. and other labor expenses.
2/ Nemitode control: 25 gal. of telone II, or 45 gal. DD, or terricide.
3/ Probably 400 lbs. of 10-20-20 but depends on soil test.
4/ Tiled, high quality farm land.
5/ About 5% of cash costs excluding harvest costs.

AgIII-XII-84
Oregon State
University

LOGANBERRIES
Enterprise Data Sheet

Cooperative
Extension Service

Based on:
1. 5 ac. on 100 ac. farm
   (½ ac. additional headlands)
2. Yield: 1st yr. (establishment) = 0
   2nd yr. = 1500 lbs./ac.
   3rd yr. = 5000 lbs./ac.
   4th - 8th yr. = 7000 lbs./ac.
3. Hired labor @ $2.00/hr.
4. Operators labor @ $3.00/hr.
5. 700 plants per acre
6. 35 HP tractor @ $2.50/hr.

INPUTS PER ACRE

PRODUCING YEARS 3 - 8	Labor		Machinery	Other		Total Cost
	Hrs.	Value ($)	($)	Item	Value ($)	($)
Cultural Operations						
Fall & winter herbicides				Custom	8.00	8.00
Train canes	40	80.00*				80.00
Insecticides 1/	1	3.00	3.00		8.00	14.00
Fungicides 1/	2.5	7.50	7.50	Mtl.	13.50	28.50
Fruit worm spray 1/	1	3.00	3.00		3.50	9.50
Rotovate (1x)	6	1.80	2.00			3.80
Cultivate (9x)	4.5	13.50	13.50			27.00
Train new canes in row	20	40.00*				40.00
Hoe	7	14.00*				14.00
Irrigate (3x, 6in.)	3	6.00*	6.00	Elec.	4.00	16.00
Remove old canes	25	50.00*				50.00
Rodent control	1	3.00		Mtl.	1.00	4.00
Harvest						
Picking (7000 lbs. @ 6¢)		420.00				420.00
Other harvest costs (1.5¢/lb.)		105.00	20.00	Supply	5.00	130.00
Other Charges						
Int. on land investment (7%) 2/					61.60	61.60
Taxes on land 2/					16.50	16.50
Int. on oper. cap. (8%)					21.55	21.55
General overhead 3/					14.60	14.60
Cash Costs		715.00	22.00		81.05	818.05
Non-cash costs		31.80	33.00		76.20	141.00
Total annual costs		746.80	55.00		157.25	959.05
Amortized Establishment cost						139.60
Total cost						1098.65
Cost per pound @ 5000 pounds yield						19.0¢
Cost per pound @ 7000 pounds yield						15.7¢
Cost per pound @ 9000 pounds yield						13.9¢
Cost per pound @ 11000 pounds yield						12.7¢

* Primarily hired labor

1/ Consult your co .ty agent for recommendations on specific cultural practices.
2/ Taxes and inter st included for headland areas.
3/ Approximately 5 of cash costs excluding harvest expense.

There data were obt ned and computed by Hugh J. Hickerson, Area Agent, Farm Management and Don Rasm n, Extension Agent in cooperation with Marion County Growers, February 1977.

ESTABLISHMENT YEARS 1 & 2	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total Cost ($)
Cultural Operations						
Plow	1	3.00	3.25			6.25
Disc & harrow (2x)	1	3.00	3.20			6.20
Rotovate (1x)	1.5	4.50	4.90			9.40
Layout field (2 men)	1	2.50		Mtl.	1.00	3.50
Plant (4 men)	12	24.00*		Plants	107.25	131.25
Fertilize (1st yr., 3 men) 1/	1.5*	3.00*	.90	Mtl.	8.00	11.90
Lay canes in row	5	10.00*				10.00
Cultivate 1st yr. (8x)	4	12.00	12.00			24.00
Irrigate (4x, 6 in. total)	3	6.00*	6.00	Elec.	4.00	16.00
Establish Yard						
Posts (200)				Post	140.00	140.00
Dig holes				Custom	20.00	20.00
Put in posts				Custom	40.00	40.00
String wire (2 men)	4	8.00*		Mtl.	25.00	33.00
Train for baby crop	16	32.00*				32.00
Fall fungicide 1/	1	3.00	5.00	Mtl.	4.20	12.20
Dormant & spring sprays 1/	1	3.00	5.00	Mtl.	7.50	15.50
Pre-harvest cult. (2nd yr.)						
Rotovate (1x)	.6	1.80	2.00			3.80
Cultivate (4x)	2	6.00	6.00			12.00
Cane borer drench 1/	1	3.00	3.00	Mtl.	8.00	14.00
Fertilize 2nd yr. 1/	1	3.00	3.00	Mtl.	17.00	23.00
Irrigate (4x, 6 in.)	3	6.00*	6.00	Elec.	4.00	16.00
Stake canes	12	24.00*		Mtl.	2.00	26.00
Remove old canes	12	24.00*				24.00
Harvest baby crop						
Picking (6¢)		90.00				90.00
Other harvest exp. (1½¢)		22.50	4.50	Supply	1.00	28.00
Other Charges						
Int. on land inv. ($800 @ 7% for 2 yrs.) 2/					123.20	123.20
Taxes on land ($15) 2/					32.00	32.00
Int. on oper. cap. (8%)					33.20	33.20
General overhead (5%) 3/					28.95	28.95
Cash costs		251.00	25.90		449.95	726.85
Non-cash costs		43.30	38.85		156.35	238.50
Total costs		294.30	64.75		606.30	965.35
Credit for baby crop (1500 lbs. @ $.20)						(300.00)
Net establishment costs						665.35
AMORTIZED ESTABLISHMENT COST (6 yrs. @ 7%)						139.60

* Primarily hired labor

1/ Consult your county agent for recommendations on specific cultural practices.
2/ Taxes and interest included for headland areas.
3/ Approximately 5% of cash costs excluding harvest expenses.

AgIII-XII-86

OREGON STATE UNIVERSITY
EXTENSION SERVICE

MARION BLACKBERRIES

Based on:

1. 10 acre on a 75 acre farm
2. Yields: Year 2 2000 lbs.
   Year 3 4000 lbs.
   Year 4-15 7000 lbs.
3. Hired labor $4.00/hr.[1]
4. Operator's labor $6.00/hr.
5. 35 h.p. tractor $6.50/hr.
6. 537 plants per acre

INPUTS PER ACRE

	Labor			Other		Total
PRODUCING YEARS	Hrs.	Value	Machinery	Item	Value	cost
		($)	($)		($)	($)
Cultural Operations[2]						
Fall & winter herbicide spray				Custom	8.50	8.50
Train canes*	60.0	240.00		Mtl.[3]	15.00	255.00
Fungicide (12 mo) (6X)	2.0	12.00	10.00	Mtl.	63.80	85.80
Cane borer drench	1.0	6.00	10.00	Mtl.	6.20	22.20
Fruit worm spray	1.0	6.00	10.00	Mtl.	3.30	19.30
Spring: Rotovate (1X)	1.0	6.00	8.30			14.30
Cultivate (5X)	2.5	15.00	15.60			30.60
Spring fertilizer	1.0	6.00	6.30	Fert.	38.70	51.00
Train canes in row*	15.0	60.00				60.00
Summer weed control	4.0	24.00		Mtl.	4.00	28.00
Irrigate (2X, 8")*	4.0	16.00	40.25	Elec.	6.47	62.72
Remove old canes*	35.0	140.00				140.00
Rotary chop canes	1.0	6.00	7.80			13.[illegible]
Harvest Costs (7000#)						
Picking labor (11¢)		770.00				770.00
Other harvest costs (3¢)		210.00				210.00
Other Charges						
Land rental value (225/ac.)					225.00	225.00
Operating capital interest (13%)					88.33	88.33
General overhead[4]					45.55	45.55
Total Cash Costs		1436.00	48.71		279.85	1764.56
Total Non-Cash Costs		81.00	59.54		225.00	365.54
TOTAL		1517.00	108.25		504.85	2130.10
Amortized establishment costs						288.66
TOTAL PRODUCING YEAR'S COSTS						2418.76
Total cost per pound @ 5000 lb./ac. yield						.43
Total cost per pound @ 7000 lb./ac. yield						.35
Total cost per pound @ 9000 lb./ac. yield						.30

(Footnotes on back.)

These data were obtained and developed by John Burt and Ken Brown, Extension Agents in cooperation with Mid-Willamette Valley berry growers.

Department of Agricultural and Resource Economics, September 1979.

INPUTS PER ACRE

ESTABLISHMENT YEARS (1&2)	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total Cost ($)
Cultural Operations[2]						
Plow	1.5	9.00	9.60			18.60
Disc & harrow (3X)	1.5	9.00	11.25			20.25
Lime (4 ton)				Custom	100.00	100.00
Layout field (2 men)	1.0	5.00		Mtl.	2.50	7.50
Pre-plant symphylan control 5/				Custom	28.75	28.75
Plant (4 men)*	10.0	40.00		Plants	187.95	227.95
Hand fertilize (3 men)*	1.0	4.00		Fert.	21.65	25.65
Lay canes in row*	6.0	24.00				24.00
Cultivate (10X)	5.0	30.00	31.00			61.00
Irrigate (3X -6")*	4.0	16.00	40.00	Elec.	6.30	62.30
Herbicide				Custom	6.75	6.75
Put in posts 200 @ 2.00				Posts	400.00	400.00
Dig holes & set posts				Custom	82.00	82.00
String tighten & staple wire	4.0	20.00		Wire	315.00	335.00
Hand hoe (3X)*	16.0	64.00				64.00
Train canes (Fall)*	12.0	48.00		Mtl.[3]	15.00	63.00
Dormant & spring spray (3X)	3.0	18.00	30.00	Mtl.	38.10	86.10
Herbicide				Custom	6.75	6.75
Fertilize (spring)	1.0	6.00	6.30	Fert.	38.70	51.00
Preharvest cultivate						
Rotovate (1X)	1.0	6.00	8.30			14.30
Cultivate (5X)	2.5	15.00	15.60			30.60
Irrigate (3x-6")*	4.0	16.00	40.00	Elec.	6.30	62.30
Train canes in row*	10.0	40.00				40.00
Remove old canes*	6.0	24.00				24.00
Rotary chop canes	1.0	6.00	7.80			13.80
Harvest Baby Crop (2000#)						
Picking labor (12¢/lb.)		240.00				240.00
Other harvest exp. (3c/lb.)		60.00				60.00
Other Charges						
Rental value of land (225/ac. for 2 yrs.)					450.00	450.00
Operating capital interest (13%)					227.92	227.92
General overhead 4/					114.22	114.22
Total Cash Costs		586.00	89.93		1597.89	2273.82
Total Non-Cash Costs		114.00	109.92		450.00	673.92
TOTAL COSTS		700.00	199.85		2047.89	2947.74
Credit for baby crop (2000# @ 50¢)						(1000.00)
Net establishment costs						1947.74
Amortization of establishment costs (11%) for 13 yrs.)						288.66

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* Indicates operation normally performed by hired labor.

1/ Includes payroll taxes and benefits.

2/ Consult your extension agent or fieldman for specific cultural operations.

3/ Gloves and shears.

4/ Estimated at 7% of cash costs, excluding harvest labor and operating capital interest.

5/ This practice is generally used, however is not always necessary.

AgIII-XII-88

OREGON STATE UNIVERSITY
EXTENSION SERVICE

THORNLESS EVERGREEN BLACKBERRIES

Based on:

1. 10 acre on a 75 acre farm
2. Yields: Year 2 2000 lbs.
   Year 3 5000 lbs.
   Year 4-15 10,000 lbs.
3. Hired labor $4.00/hr.[1]
4. Operator's labor $6.00/hr.
5. 35 h.p. tractor $6.50/hr.
6. 537 plants per acre

INPUTS PER ACRE

PRODUCING YEARS	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[2]						
Fall-winter herbicide				Custom	8.50	8.50
Spring fertilizer	1.0	6.00	6.30	fert.	52.50	64.80
Train canes*	60.0	240.00		Mtl.[3]	15.00	255.00
Fungicides (12 mo)(4X)	1.3	7.80	10.00	Mtl.	39.90	57.70
Red berry mite control	1.0	6.00	10.00	Mtl.	9.20	25.20
Cane borer drench	1.0	6.00	10.00	Mtl.	6.20	22.20
Fruit worm spray	1.0	6.00	10.00	Mtl.	3.30	19.30
Spring: Rotovate (1X)	1.0	6.00	8.30			14.30
Cultivate (5X)	2.5	15.00	15.60			30.60
Train canes in row*	30.0	120.00				120.00
Summer weed control	7.0	42.00		Mtl.	4.00	46.00
Irrigate (3X, 12")*	4.0	16.00	40.25	Elec.	9.70	65.95
Remove old canes*	25.0	100.00				10[illegible]0
Rotary chop canes	1.0	6.00	7.80			13.80
Harvest costs (10,000#)						
Picking labor (11¢/lb.)		1100.00				1100.00
Other harvest exp. (3¢/lb.)		300.00				300.00
Other Charges						
Rental value of land (225/ac.)					225.00	225.00
Operating capital interest (13%)					112.53	112.53
General overhead [4]					47.43	47.43
Total Cash Cost		1876.00	53.21		308.26	2237.47
Total Non-Cash Cost		100.80	65.04		225.00	390.84
TOTAL PRODUCING YEAR'S COSTS		1976.80	118.25		533.26	2628.31
Amortized Establishment Costs						291.10
TOTAL COSTS						2919.41
Total cost per pound @ 8,000 lb./ac. yield						.33
Total cost per pound @ 10,000/lb./ac. yield						.29
Total cost per pound @ 12,000 lb./ac. yield						.27

(Footnotes on back.)

These data were obtained and developed by John Burt and Ken Brown, Extension Agents in cooperation with Mid-Willamette Valley berry growers.

Department of Agricultural and Resource Economics, September 1979.

ESTABLISHMENT YEARS (1&2)	Labor		Machinery	Other		Total cost
	Hrs.	Value		Item	Value	
		($)	($)		($)	($)
Cultural Operations 2/						
Plow	1.5	9.00	9.60			18.60
Disc & harrow (3X)	1.5	9.00	11.25			20.25
Lime (4 ton)				Custom	100.00	100.00
Layout field (2 men)	1.0	5.00		Mtl.	2.50	7.50
Pre-plant symphylan control 5/				Custom	28.75	28.75
Plant (4 men)*	10.0	40.00		Plants	187.95	227.95
Hand fertilize*	1.0	4.00		Fert.	15.75	19.75
Lay canes in row*	5.0	20.00				20.00
Cultivate (10X)	5.0	30.00	31.00			61.00
Irrigate (3x-6")*	4.0	16.00	40.00	Elec.	6.30	62.30
Herbicide				Custom	6.75	6.75
Put in posts 200 @ 2.00				Posts	400.00	400.00
Dig holes & set posts				Custom	82.00	82.00
String tighten & staple wire	4.0	20.00		Wire	315.00	335.00
Hand hoe (3X)*	16.0	64.00				64.00
Training & pruning*	20.0	80.00		Mtl. 3/	15.00	95.00
Dormant & spring sprays and dust(3X)	3.0	18.00	30.00	Mtl.	32.00	80.00
Herbicide				Custom	6.75	6.75
Fertilize (spring)	1.0	6.00	6.30	Fert.	31.50	43.80
Preharvest cultivate						
Rotovate (1X)	1.0	6.00	8.30			14.30
Cultivate (5X)	2.5	15.00	15.60			30.60
Irrigate (3X-6")*	4.0	16.00	40.00	Elec.	6.30	62.30
Train canes in row*	10.0	40.00				40.00
Remove old canes*	6.0	24.00				24.00
Rotary chop canes	1.0	6.00	7.80			13.80
Harvest Baby Crop (2000#)						
Picking labor (12¢/lb.)		240.00				240.00
Other harvest exp. (3¢/lb.)		60.00				60.00
Other Charges						
Rental value of land (225/ac. for 2 yrs.)					450.00	450.00
Operating capital interest (13%)					226.00	226.00
General overhead 4/					123.85	123.85
Total Cash Costs		614.00	89.93		1586.40	2290.33
Total Non-Cash Costs		114.00	109.92		450.00	673.92
TOTAL COSTS		728.00	199.85		2036.40	2964.25
Credit for baby crop (2000# @ 50¢)						(1000.00)
Net establishment costs						1964.25
Amortization of establishment costs (11% for 13 yrs.)						291.10

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* Indicates operation normally performed by hired labor.

1/ Includes payroll taxes and benefits.

2/ Consult your extension agent or fieldman for specific cultural operations.

3/ Gloves and shears.

4/ Estimated at 7% of cash costs, excluding harvest labor and operating capital interest.

5/ This practice is generally used, however is not always necessary.

Appendix H

STRAWBERRY YEARLY CALENDAR

JANUARY - Repair and maintenance of equipment (don't forget irrigation equipment or to check sprayer nozzle disks for wear).

Evaluate what went wrong during the previous year.

FEBRUARY - Continue January activities.

MARCH - New Plantings.

Prepare land for planting.

Apply insecticide for weevil control.

Established Plantings.

Cultivate and shape rows.

Apply herbicide (for heavy chickweed infestations use Tenoran with wetting agent).

Hand weed if necessary.

APRIL - New Plantings.

Start planting when conditions allow.

Control weeds chemically within 2 weeks after planting

Established Plantings.

Continue March activities.

Watch fields for aphid, spittle bugs, and mite build-up and control if necessary.

At 5 percent bloom, start fungicide applications for fruit rot control and continue at weekly intervals until harvest.

MAY - New Plantings.

Fertilize as soon as growth has started with half the. total amount required, as determined by fertilizer test.

Irrigate if necessary.

Follow insect control program.

Established Plantings.

Continue April activities.

Watch for slugs and control if necessary.

Under dry conditions, irrigate if possible to maintain fruit development.

Prepare for harvest in early June.

JUNE - New Plantings.

Hand weed if necessary.

Follow insect control program.

Irrigate if necessary.

Control runners in hill system.

Established Plantings.

Prepare for harvest.

Start harvest. (Make sure to have adequate supervision).

Maintain fruit quality until fruit reaches processor.

JULY - New Plantings.

Fertilize second half of the total amount of fertilizer required, as determined by fertilizer test.

Apply herbicide if necessary.

Follow insect control program.

Control runners in hill system.

Established Plantings.

Continue harvest.

Clean up after harvest.

Possibility of summer planting.

Go fishing.

AUGUST - New Plantings.

Continue previous month insect and runner control program.

Established Plantings.

Apply fertilizer as determined by soil test.

Clip foliage if so desired.

Control insects, mites and mildew.

Close cultivate.

Irrigate.

Hand weed if necessary.

Order new plants, fertilizer and pesticides.

SEPTEMBER - New Plantings.

Shape beds (hilling, listings).

Subsoil.

Hand weed if necessary.

OCTOBER - New Plantings.

Apply herbicide when soil is settled and adequate soil moisture is available. Plantings should be free od weeds.

Established Plantings.

Apply herbicide when soil is settled and adequate soil moisture is available. Plantings should be free of weeds.

NOVEMBER - See January activities.

DECEMBER - See January activities.

CANE BERRY YEARLY CALENDAR

JANUARY - Repair and maintence of equipment. Don't forget irrigation equipment or to check sprayer nozzles.

FEBRUARY - Continue January activities.
Begin tying topping or wrapping canes.

MARCH - New Plantings.
Prepare land for planting.
If weather holds plant.
Established Plantings.
Cultivate and shape rows.
Apply herbicides for heavy infestations.
Hand weed if necessary.
Drench for Crown Bore.
Spray for fungus growth.

APRIL - New Plantings.
Plant when conditions allow.
Control weeds chemically as soon as possible.
Prune new plants to 6 to 8 inches in height.
Established Plantings.
Continue March's activities.
Watch fields for insect build-up and control when necessary.
Fertilize following your fall leaf and soil analysis test results.
Remove all sucker type growth in and between rows.

MAY - New Plantings.
Fertilize as soon as plants have begun growth, use ½ recommended amount as determined by soil analysis.
Watch for insect problems.
Continue ground cultivation and weed control.
Established Plantings.
Apply Burn Back when new canes reach 4 to 8 inches tall.
Continue weed control.
Put in bee nives when blooms begin.
Continue watchful eye insect build-up.

JUNE - New Plantings.
Hand hoe rows if necessary.
Watch for insect damage.
Fertilize second half of annual fertilizer.
Established Plantings.
Prepare for harvest.
Control insects expecially planning mechanical harvesting.
Control weeds.
Follow recommended fungicide program to prevent fruit rot.
Final inspection of harvest equipment
Line up enough of a crew.

JULY - New Plantings.
Apply herbicide if necessary
Continue insecticide program if necessary.
Established Plantings.
Continue insecticide and fungicide programs.
Start picking.
Maintain fruit quality until it reaches market or processor.

AUGUST - New Plantings.
Continue previous program
Established Plantings.
Continue Harvest
Maintain quality through effective spray program.
Clean up field follow
Collect leaf and soil sample for follow program.

SEPTEMBER - New Plantings.
Hand weed if necessary
Continue effective weed control program.
Established Plantings.
Cane out old fruit canes
Cultivate.
Apply full herbicide program if necessary.

OCTOBER - See September activities.

NOVEMBER - New Plantings.
As soon as ground softens plan putting in post and trellis.

DILUTION TABLE FOR PESTICIDES

Pesticide Formulation	Amount of Formulation Needed Per Acre to Obtain the Following Amounts of Active Chemical Per Acre						
	1/8 lb.	1/4 lb.	1/2 lb.	3/4 lb.	1 lb.	2 lbs.	3 lbs.
1% dust	12 1/2 lbs	25 lbs	50 lbs	75 lbs	100 lbs	200 lbs	300 lbs
5% dust	2 1/2 lbs	5 lbs	10 lbs	15 lbs	20 lbs	40 lbs	60 lbs
10% dust	1 1/4 lbs	2 1/2 lbs	5 lbs	7 1/2 lbs	10 lbs	20 lbs	30 lbs
18 1/2% wettable powder	2/3 lb	1 1/3 lbs	2 2/3 lbs	4 lbs	5 1/3 lbs	10 2/3 lbs	16 lbs
25% wettable powder	1/2 lb	1 lb	2 lb	3 lb	4 lbs	8 lbs	12 lbs
50% wettable powder	1/4 lb	1/2 lb	1 lb	1 1/2 lbs	2 lbs	4 lbs	6 lbs
75% wettable powder	1/6 lb	1/3 lb	2/3 lb	1 lb	1 1/3 lbs	2 2/3 lbs	4 lbs
Emulsifiable concentrate, contains 1 lb. active ingredient/gal.,10-12%	1 pt	1 qt	2 qts	3 qts	1 gal	2 gals	3 gals
Emulsifiable concentrate, contains 2 lbs. active ingredient/gal.,about 25%	1/2 pt	1 pt	1 qt	3 pts	2 qts	1 gal	1 1/2 gals
Emulsifiable concentrate, contains 4 lbs. active ingredient/gal.,about 50%	1/4 pt	1/2 pt	1 pt	1 1/2 pts	1 qt	2 qts	3 qts
Emulsifiable concentrate, contains 8 lbs. active ingredient/gal., about 75%	1/8 pt	1/4 pt	1/2 pt	3/4 pt	1 pt	1 qt	1 1/2 qts

FORMULATION REQUIRED PER 100 GALLONS OF WATER TO OBTAIN PERCENTAGE OF ACTUAL CHEMICAL

Insecticide Formulation	Formulation Required Per 100 Gallons of Water to Obtain Following Percentages of Actual Chemical				
	0.25%	0.5%	1%	2%	5%
25% wettable powder	8 lbs	16 lbs	32 lbs	64 lbs	160 lbs
50% wettable powder	4 lbs	8 lbs	16 lbs	32 lbs	80 lbs
75% wettable powder	2 2/3 lbs	5 1/3 lbs	10 2/3 lbs	21 1/2 lbs	53 1/3 lbs
12% emulsifiable concentrate,(1 lb. active ingredient/gal.)	2 1/2 gals	4 1/6 gals	8 1/3 gals	16 2/3 gals	41 2/3 gals
20% emulsifiable concentrate, (1 1/2 lbs. active ingredient/gal.)	1 1/4 gals	2 1/2 gals	5 gals	10 gals	25 gals
45% emulsifiable concentrate, (4 lbs.active ingredient/gal.)	1/2 gal	1 1/8 gals	2 1/4 gals	4 1/2 gals	11 1/4 gals
75% emulsifiable concentrate, (8 lbs. active ingredient/gal.)	1/3 gal	2/3 gal	1 1/3 gals	2 2/3 gals	6 2/3 gals

DILUTION FOR WETTABLE POWDER AND EMULSIFIABLE CONCENTRATES

Type of Material	Quantities of Material for Indicated Quantities of Water			
	100 Gallons	5 Gallons	3 Gallons	1 Gallon
Wettable Powder	5 lbs	15 T.	10 T.	3 T.
	4 lbs	13 T.	8 T.	8 T.
	3 lbs	10 T.	6 T.	2 T.
	2 lbs	8 T.	4 T.	4 t.
	1 lb	3 T.	2 T.	2 t.
	1/2 lb	5 t.	1 T.	1 t.
Emulsifiable concentrate	5 gals	1 qt	1 1/4 pts	13 T.
	4 gals	1 1/2 pts	1 pt	10 T.
	3 gals	1 1/4 pts	3/4 pt.	1/4 pt.
	2 gals	3/4 pt	1/2 pt	5 T.
	1 gal	1/2 pt	8 T.	3 T.
	1 qt	3 T.	2 T.	2 t.
	1 pt	5 t.	1 T.	1 t.

WEIGHTS and MEASURES

WEIGHTS

	METRIC EQUIVALENT
1 ton = 2,000 lbs.	0.907 metric tons
1 lb. = 16 oz. = 7,000 grains	0.453 kilograms
1 oz. = 437.5 grains	28.349 grams
1 short hundredweight = 100 lbs.	45.359 kilograms
1 long hundredweight = 112 lbs.	50.802 kilograms
1 short ton = 2,000 lbs.	0.907 metric tons
1 long ton = 2,240 lbs.	1.016 metric tons
1 kilogram = 1,000 grams = 2.2046 lbs.	
1 gram = 1,000 milligrams	
1 metric ton = 1,000 kilograms = 2,204.62 lbs.	

CAPACITY (liquid measure)

1 barrel = 31.5 gals.	
1 gal. = 4 qts. = 8 pts. = 16 cups = 128 fluid oz.	3.785 liters
1 qt. = 2 pts. = 4 cups = 32 fluid oz. = 64 tbsp.	0.946 liters
1 pt. = 4 gills = 2 cups = 16 fluid oz. = 32 tbsp.	0.473 liters
1 cup = 8 fluid oz. = 16 tbsp. = 48 tsp.	0.237 liters
1 tbsp. = 3 tsp.	15 milliliters
1 tsp. = 80 drops	5 milliliters
1 liter = 1,000 milliliters = 1.05671 qts. = 2.11342 pts.	

LENGTH

1 mile = 5,280 ft. = 1,760 yds. = 320 rods = 80 chains	1.609 kilometer
1 chain = 66 ft. = 22 yds. = 4 rods = 100 links	1.257 meters
1 yard = 3 ft. = 36 in.	0.914 meters
1 ft. = 12 in	30.480 centimeter
1 mile an hr. = 88 ft. per minute	26.82 meters per min.
1 kilometer = 1,000 meters = 0.62137 mile	
1 meter = 100 centimeters = 39.37 in. = 3.28 ft.	
1 centimeter = 0.3937 in.	

AREA

1 sq. mile = 640 acres	2.590 sq. kilometers
1 acre = approx. 209 x 209 ft. = 4840 sq. yds. = 43,560 sq. ft.	0.405 hectares
1 sq. yd. = 9 sq. ft.	0.836 sq. meters
1 sq. ft. = 144 sq. in.	0.093 sq. meters
1 hectare = 10,000 sq. meters	

SPEED

1 mile per hr. = 88 ft. per minute	26.82 meters per min.

FERTILIZER CONVERSION TABLE

Per acre rates converted to amounts need per 100 ft. of row
at the given row spacings*

Distance between row	12 inches	18 inches	24 inches	36 inches	48 inches
300 lbs. per acre	11 oz.	1 lb.	1 lb. 6 oz.	2 lb.	2 lb. 12 oz.
400 lbs. per acre	15 oz.	1 lb. 7 oz.	1 lb. 12 oz.	2 lb. 12 oz.	3 lb. 10 oz.
500 lbs. per acre	1 lb. 2 oz.	1 lb. 12 oz.	2 lb. 4 oz.	3 lb. 8 oz.	4 lb. 8 oz.
600 lbs. per acre	1 lb. 6 oz.	2 lb.	2 lb. 12 oz.	4 lb.	5 lb. 8 oz.
700 lbs. per acre	1 lb. 10 oz.	2 lb. 8 oz.	3 lb. 4 oz.	4 lb. 8 oz.	6 lb. 8 oz.
800 lbs. per acre	1 lb. 14 oz.	2 lb. 12 oz.	3 lb. 8 oz.	5 lb. 8 oz.	7 lb.
1000 lbs. per acre	2 lb. 4 oz.	3 lb. 8 oz.	4 lb. 8 oz.	6 lb. 14 oz.	9 lb.

RATES OF APPLICATION FOR SMALLER AREAS

Equivalent Rates for Areas Indicated

Rate per acre	1000 sq. ft.	100 sq. ft.	1 sq. yd.
100 lbs.	2.5 lbs.	0.25 lbs.	0.4 oz.
200 lbs.	5.0 lbs.	0.50 lbs.	0.8 oz.
300 lbs.	7.5 lbs.	0.75 lbs.	1.2 oz.
400 lbs.	10.0 lbs.	1.00 lbs.	1.6 oz.
500 lbs.	12.5 lbs.	1.25 lbs.	2.0 oz.
600 lbs.	15.0 lbs.	1.5 lbs.	2.4 oz.
700 lbs.	17.5 lbs.	1.75 lbs.	2.8 oz.
800 lbs.	20.0 lbs.	2.00 lbs.	3.2 oz.
900 lbs.	22.5 lbs.	2.25 lbs.	3.6 oz.
1000 lbs.	25.0 lbs.	2.5 lbs.	4.0 oz.
2000 lbs. (1 T)	50.0 lbs.	5.0 lbs.	8.0 oz.
4000 lbs. (2 T)	100.0 lbs.	10.0 lbs.	1.0 lbs.
4 tons	200.0 lbs.	20.0 lbs.	2.0 lbs.
6 tons	300.0 lbs.	30.0 lbs.	3.0 lbs.
10 tons	500.0 lbs.	50.0 lbs.	5.0 lbs.
15 tons	750.0 lbs.	75.0 lbs.	7.5 lbs.

*The application of one half the material to each side of the row is recommended.

Appendix J

DEFINITIONS OF FREQUENTLY ENCOUNTERED TERMS

Active ingredient: That portion of a pesticide formulation that is toxic to pests.

Carrier: An inert material mixed with active ingredients to make a pesticide formulation. Example: Finely divided clay of talc.

Compatibility: Materials in a spray or dust mixture are compatible if one does not reduce the effectiveness of the other and if crop injury does not result from use of the combination.

Detergent: A cleaning agent. Because of their surface active properties, detergents have a variety of other uses. (See Surfactant)

Dust: A finely divided carrier containing an active ingredient, usually of low concentration, to be used without dilution.

Emulsifiable concentrage: A liquid pesticide consisting of active ingredient solvent and emulsifier that mixes with water to form an emulsion (e.g. diazinon 50 EC).

Flowable or paste: Sometimes referred to as colloidal formulations, these are in a finely divided state. Because of smallness of particle size, specific gravity of the suspending medium, and the presence of suspending and dispersing agents, the formulation remains almost indefinitely in a suspended state.

Food and Drugs Act: The Federal Act which regulates the purity of foods and drugs sold to the public.

Fumigation: The use of chemicals in gaseous form to destroy pests or disease organisms.

Granular pesticide: A pesticide formulation in the form of relatively course particles which are applied dry with a spreader, seeder, or special applicator (e.g. Casoron 4G).

Nematicide: A pesticide used to control nematodes.

Pest Control Products Act: A Federal Act administered by the Canada Department of Agriculture. The Act provides that, in order to be registered for sale in Canada, a pesticide must be accompanied with evidence of effectiveness for the purposes claimed, and it must be accurately labelled as to composition and hazards. The seller must also provide adequate directions for use. Resigtration is authorized by the Plant Products Division of the Department of Agriculture.

GRASS SEED PRODUCTION

INSTRUCTOR'S GUIDE

1. This unit was developed to provide information relating to the cultural practices of grass seed production.
2. Emphasis is given to the study of the dominant grass seed varieties produced in Oregon.
3. Grass seed samples should be utilized extensively to help students learn identification and characteristics of common grass seed crops.
4. Field trips are necessary for students to grasp the concepts of approved practices for growing grass seed crops.
5. A land laboratory or other field site allows the use of demonstration sites for grass seed crops. Seedbed preparation, seeding, fertilizing methods, fertilizing rates, variety tests and harvesting methods can best be taught by "hands on" involvement of the students.

OBJECTIVES

Upon completion of this unit, the student will be able to:

1. Identify the common grass varieties during growth and as harvested seed.
2. Describe the cultural practices for grass seed production.
3. Describe the types, growth habits and utilization of Bentgrass.
4. Describe the types, growth habits and utilization of Fine Fescue.
5. Describe the types, growth habits and utilization of Kentucky Bluegrass.
6. Describe the types, growth habits and utilization of Perennial Ryegrass.
7. Describe the types, growth habits and utilization of Tall Fescue.
8. Describe the types, growth habits and utilization of Annual Ryegrass.

9. Describe the types, growth habits and utilization of Orchardgrass.
10. Identify steps in developing an improved field.
11. Prepare a seedbed for grass seed crops.
12. Seed and fertilize grass seed crops.
13. Control weeds in grass seed crops.
14. Harvest grass seed crops.

TEACHING AIDS

1. Extension Bulletins and Circulars on growing the various grass seed crops.
2. Fertilizer guides relating to the various grass seed crops.
3. Grass seed samples, both seed and plant samples.
4. Machinery manuals:
   John Decre Manuals
   John Deere Road
   Moline, Illinois 61265

   Fundamentals of Machinery Operation:
   - Crop Chemicals
   - Tillage
   - Planting
   - Hay and Forage Harvesting
   - Combine Harvesting
   - Machinery Management
   - Tractors
   - Agricultural Machinery Safet
   - Preventive Maintenance
5. Various slides of pests, disease and weed problems in grass seed production.
6. Oregon Weed Control Handbook.
7. Oregon Insect and Disease Control Handbook.
8. Oregon Certified Seed Handbook.

STUDENT ACTIVITIES

1. Read the objectives of the unit.
2. Study the material provided by the instructor.

3. Examine the grass seed samples as provided by the instructor.
4. Visit fields of various grass seed production during growth, as part of field trip or individual assignments.
5. Participate in preparing a seedbed for grass seed crops.
6. Assist in fertilization of grass seed crops.
7. Assist in weed control of grass seed crops.
8. Participate in the harvesting of the grass seed crops.
9. Compile an Ag notebook for grass seed production.

REFERENCES

1. Variety recommendation and production sheet: OSU Extension Office.
2. Fertilizer Guides: OSU Extension Office.
3. Enterprise Data Sheets: OSU Extension Office.
4. Oregon Certified Seed Handbook: OSU Extension Office.
5. Oregon Weed Control Handbook: OSU Extension Office.
6. Oregon Disease Control Handbook: OSU Extension Office.
7. Oregon Seed Council, 2140 Turner Road, S.E., Salem, Oregon 97302 (503) 585-1157.
8. Orchardgrass Seed Production in Western Oregon: OSU Extension Office.
9. Northwest Chemical Corporation: Clean Crop Label Guide, 4560 Ridge Drive, Salem, Oregon 97303, (503) 390-3030.
10. Other appropriate information may be acquired from Grass Seed Producers as well as those involved in the various Grass Seed Companies as field representatives.

INTRODUCTION IDEAS

1. It is suggested to obtain information on the Grass Seed Industry as provided by the Oregon Seed Council. They will provide excellent background information on the grass seed industry.
2. Teach only crops information which in pertinent to your local area.

TABLE OF APPENDICES

1. Appendix A: 1982 Estimated Cash receipts from Farm Marketings

2. Appendix B: Growing Kentucky Bluegrass for forage
   Growing Perennial Ryegrass for forage
   Growing Tall Fescue for forage
   Growing Orchardgrass for forage

3. Appendix C: Fertilizer Guide for Turfgrass
   Fertilizer Guide for Bluegrass seed
   Fertilizer Guide for Annual Ryegrass seed
   Fertilizer Guide for Perennial Ryegrass seed
   Fertilizer Guide for Tall Fescue
   Fertilizer Guide for Orchardgrass seed

4. Appendix D: Enterprise Data Sheet for Bentgrass Seed
   Enterprise Data Sheet for Fine Fescue
   Enterprise Data Sheet for Kentucky Bluegrass
   Enterprise Data Sheet for Annual Ryegrass
   Enterprise Data Sheet for Perennial Ryegrass
   Enterprise Data Sheet for Tall Fescue
   Enterprise Data Sheet for Orchardgrass Seed

5. Appendix E: The Oregon Seed Certification Program

6. Appendix F: Oregon Weed Control Recommendations for Grass and Legume Seed Crops

7. Appendix G: Grass Seed Pests

8. Appendix H: Speciman Labels for Chemicals used in Grass Seed Production (Labels not included in Appendix H are CIPC, Ansar and Tilt):

2-4D
MCPA
Banvel
Buctril
Karmex
Nortron
CIPC
Atraszin
Ansar
Simizine
Paraquet
Roundup
Dowpon
Brominal
} Weed Control

Bravo
Bayleton
Tilt
} Disease Control

Malathion
Diazinon
Sevin
Dyfonate
} Insect Control

9. Appendix I: Clean Grass Seed Crops Established with Activated Carbon Bands and Herbicides
   Cascade Growers Report: Charcoal Band Planting Successful

10. Appendix J: Potention for Growth Retardants in Grass Seed Production
    1982 Seed Production Research.

COMMON TERMS AND DEFINITIONS

1. Warm season grasses: grasses that grow best between 75-100 degrees F

2. Cool season grasses: grasses that grow best between 60-75 degrees F

3. Rhizomes: underground stems

4. Stolons: above ground stems

5. Annual: a plant which grows from seed, completes its life cycle and dies during the same year

6. Winter annual: plant species that initiates growth in the fall, lives over winter and dies after producing seed the following season

7. Biennial: a plant which completes its life cycle in two years; produces leaves and roots the first year; stems, flowers and seeds the second year

8. Perennial: a plant which lives for more than two years; reproduces itself by means of seed, roots, stolons, rhizomes, tubers or bulbs

9. Alkaline: a term used to describe a solution or substance which has a pH above 7 and is therefore basic in nature

10. Acid: a term used to describe a solution or substance which has a pH below 7 and is therefore acid in nature

11. Tillering: refers to a grass plant in the vegetative growth stage when the basal tiller buds are forming and only leaves are being produced

12. Jointing: the stage of growth in a grass plant when the internodes of the stem begin to elongate

13. Heading: the grass flower is formed

14. Boot: the whorl or rolled sheath and blade always found at the top of a grass plant until the inflorescence appears

15. Florets: individual grass flowers

16. Inflorescence: the entire floral portion of a plant

17. Spike: a type of grass inflorescence or head in which the spikelets are without pedicels and are attached directly to the rachis

18. Spikelets: the basic unit of grass inflorescence

19. Panicile: an inflorescence of head in which the flowers are borne on the end of loosely divided branches that are attached to the main stem

20. Rachis: the central axis of an inflorescence or a head

21. Band seeding: the placement of seed in the soil surface directly over a fertilizer band, thus increasing the emergence and vigor of the seed

22. Crop residue: portion of plants remaining after seed harvest

23. Companion crop: crop sown with another crop, usually a small grain with which a forage crop is seeded

24. Public variety: a variety grown and sold by any individual

25. Private variety: a variety owned by a private company who raise it, advertize it and sells it

GROWING GRASS SEED

Grass and legume seeds (commonly known as the "seed industry") are important to the economy of Oregon. Oregon is the world leader in production of the fine quality, temperate climate forages and turfgrass seeds. Oregon ships these high quality seeds to almost every state of the union as well as to many of the countries in Europe, Asia, Africa, South America and the Orient.

Grass seed developed as a major crop in Oregon in the early 1930's. Grass seed, especially ryegrass, produces quite well on the poorly drained soils of the Willamette Valley.

The climate is ideal for the grass seed industry. Wet, moderate winters provide for good growth and root development. The warm, dry summers allow the seed to mature and be harvested without any artificial means of drying the grass seed.

USES OF GRASS SEED

Grass seed is produced for a variety of uses. Primarily it is grown for lawn and turf seed. Many football fields, soccer fields and golf courses have been established from the grass seed produced in Oregon. Grass seed is also produced to establish pastures for various types of livestock.

ADAPTATION

The production of grass seed is primarily centralized in the Willamette Valley. But, grass seed is grown in the Madras, La Grande, Klamath Falls and Medford areas of the state.

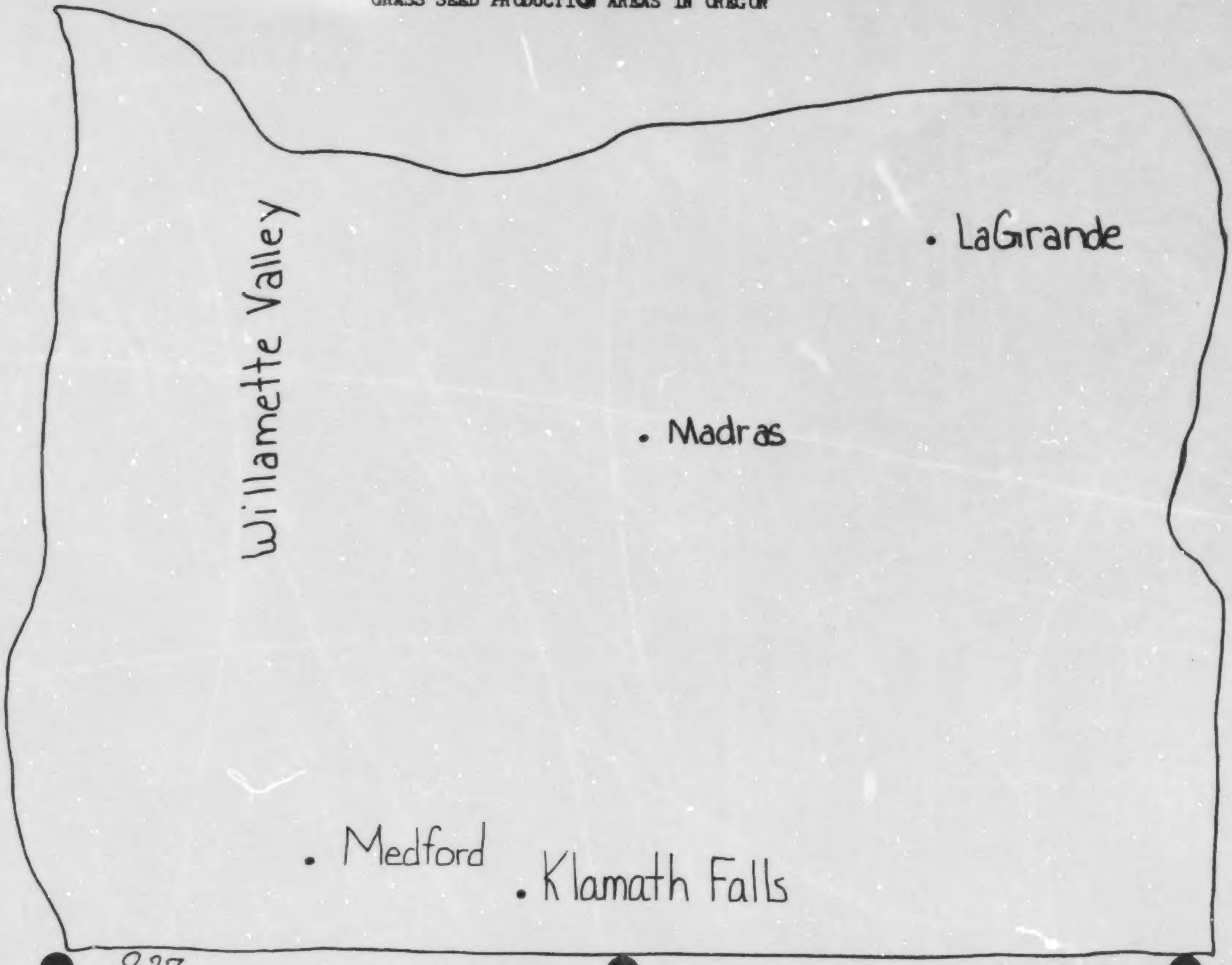
Grass seed production requires wet, moderate winters for good growth as well as for root development. Warm, dry summers allow the seed to mature and be harvested without the need for any means of artificial drying.

Grass seed production tends to produce well on poorly drained soils.

Oregon

GRASS SEED PRODUCTION AREAS IN OREGON

AgIII-XIII-8


Willamette Valley
LaGrande
Madras
Medford
Klamath Falls

KINDS OF GRASS SEED

The following varieties of grasses are arranged from the very fine grass seed varieties to the more turf and forage type grasses. Bentgrass and Fine Fescue are the finer types of grasses where the more turf types are Kentucky Bluegrass, Perennial Ryegrass, Tall Fescue and Annual Ryegrass. Orchardgrass, being the more course, is used primarily in pasture production (refer to Appendix B).

1. Bentgrass: The tiniest of all grass seed, averaging approximately 8 million seeds per pound. Mostly used for soccer fields, golf courses, cricket pitches and other fine turf situations.

2. Fine Fescue: Primarily used for golf courses, lawns, parks and shaded areas.

3. Kentucky Bluegrass: There is more Kentucky Bluegrass grown in Oregon than in Kentucky. It is used in lawn mixtures.

4. Perennial Ryegrass: The ryegrasses are the fastest germinating of all the grasses. It grows well in shaded areas. It is used for football fields as well as pastures.

5. Tall Fescue: It is primarily used for pastures and in some cases athletic fields.

6. Annual Ryegrass: Annual Ryegrass, like Perennial Ryegrass, germinates very quickly. In cases as fast as 5-7 days. It is commonly used for pasture and hay in sheep, dairy and beef production.

7. Orchardgrass: It is the coursest of all of the grass varieties. It is used for pasture production.

WHAT FACTORS TO CONSIDER BEFORE SELECTING A VARIETY

When selecting a variety, one must consider several factors, 1) What is grown in the area? 2) What types of grass are already grown on the farm? 3) Adaptability of the grass to be grown in a specific location.

What varieties are grown in the area and what is already produced on the farm have a great significance in the final outcome of marketing the grass seed. Having grass seed varieties that are compatable is very important. One should consider producing all forage or all turf varieties. An example would be that of a field of Fine Fescue that has been contaminated with Tall Fescue or Ryegrass. The contaminants in turn will reduce the quality and value of the Fine Fescue seed.

Adaptability should also be considered. The following is a list of the various grass seed varieties and their adaptabilities (refer to Appendix B).

1. Bentgrass: grows on very acid soils; on poor clayey soils of low fertility and on poorly drained soils
2. Fine Fescue: adapted to shady and dry sites; does well on poor soils; somewhat drought tolerant
3. Kentucky Bluegrass: has a wide soil adaptation, but does best on well-drained, highly productive soils; prefers open sunlight but it grows in lightly shaded situations if moisture and nutrients are favorable; survives severe droughts
4. Perennial Ryegrass: less winter-hardy than other forage grasses; grows on wide range of soil types; grows in wet areas
5. Tall Fescue: adapted to a wide range of climatic conditions; makes its best growth under relatively cool growing conditions; tolerant of poor drainage; one of the more drought resistant grasses
6. Annual Ryegrass: refer to Perennial Ryegrass
7. Orchardgrass: somewhat heat tolerant; grows rapidly in cool temperatures--especially productive in early spring; moderately winter-hardy; shade tolerant; drought tolerant

WHAT PRACTICES ARE RECOMMENDED FOR GROWING GRASS SEED?

Good management practices are essential if optimum fertilizer responses are to occur. These good management practices include the use of recommended varieties of grass seed, weed control, disease and insect control, good seed bed preparation, proper seeding methods and timely harvest. Also, recommended soil sampling procedures should be followed in order to estimate fertilizer needs (refer to Appendix C).

A. Fertilization Practices

1. Bentgrass: In the fall apply 25-35 lbs. nitrogen/acre, 30 lbs. phosphorus and apply potassium as needed as indicated by a soils test. Apply 80-95 lbs. nitrogen/acre in the spring between March 15 and April 15.

2. Fine Fescue: Apply 25-35 lbs. nitrogen/acre in the fall. Apply 30 lbs. phosphorus/acre in the fall and apply potassium as indicated by a soils test. In the spring apply 80-95 lbs. nitrogen/acre between March 1 and April 1.

3. Kentucky Bluegrass: New seedlings require 20-40 lbs. nitrogen/acre near the seed. On established stands, 100-120 lbs. nitrogen/acre is suggested. Apply 20-30 lbs. nitrogen/acre in the fall, this will help stimulate tiller production. Apply 70-100 lbs. nitrogen/acre in March. Phosphorus should be broadcast in the fall on established stands. Potassium should be broadcast on established stands in the fall. Soil pH should be around 5.8.

4. Perennial Ryegrass: Fall application includes applying 20-30 lbs. nitrogen/acre at planting time. Apply phosphorus in the fall as well as 10-15 lbs. surfur/acre. Spring application includes applying 80-100 lbs. nitrogen/acre between March 1-April 30. Soil pH should be around 5.5

5. Tall Fescue: Apply 50-60 lbs. nitrogen/acre in the fall to established stands. Do not make spring applications of nitrogen until grazing has been completed, then apply 90-100 lbs. nitrogen/acre. Phosphorus applied to established stands should be broadcast in the fall. Potassium applied to established stands should be broadcast in the fall. Soil pH should be around 5.5.

6. Annual Ryegrass: Refer to Perennial Ryegrass.

7. Orchardgrass: Apply 20-30 lbs. nitrogen/acre in the fall. Make one or two applications totalling 100-120 lbs. nitrogen/acre between March 1-April 1. Do not make spring applications until grazing is completed. Phosphorus and potassium should be broadcast in the fall.

B. Preparing the Land

1. Bentgrass: Since Bentgrass is a smaller seed than most, it requires a finer prepared seedbed. It needs a finer textured seedbed as well as being a firm seedbed.

2. Fine Fescue: Fine Fescue needs to be seeded on soils that are better drained, it cannot withstand very wet soils. It also needs a smooth and level seedbed.

3. Kentucky Bluegrass: Kentucky Bluegrass is very similiar to Bentgrass. It is also a very small seed and therefore, requires a fine textured and firm seedbed.

4. Perennial Ryegrass: Perennial Ryegrass will tolerate more wet soils than other grass seed varieties. It also makes use of the management practice of "Carbon Planting" which involves using 25 lbs. of activated carbon/acre sprayed in a one inch band over the furrow. Then the field is sprayed with 3 lbs./acre of the chemical named Karmex. The carbon protects the seed while Karmex kills all of the weeds between the furrows. Other grass seed varieties use this practice, such as Fine Fescue and Tall Fescue.

5. Tall Fescue: Tall Fescue tolerates wetter type soils. It needs a smooth level seedbed. Carbon Planting is also used in the seeding of Tall Fescue.

6. Annual Ryegrass: Annual Ryegrass tolerates wetter soils. It requires a smooth and level seedbed.

7. Orchard Grass: Orchard Grass needs to be seeded on soils that have good drainage. It needs a smooth level seedbed.

Minimum tillage has been practiced recently in grass seed production. An example of this would be that of seeding wheat as a crop, harvesting the seed and then burning the stubble. Once the stubble is burned, a selected herbicide is used. Once completing this management practice, the grass seed is then planted.

C. Seed and Seedling (Certification of Seed and Seedling)

The Oregon Seed Certification Service provides a system for the maintenance and increase of quality seed and propagating materials of the new varieties that are entered into the program, each has special characteristics of disease resistance, productivity, environmental adaptations and other characteristics that make the variety unique (refer to Appendix E).

1. Production of Certified Seed

   a. Application for Field Inspection

      1) Application for field inspection serves as notification, registration and an agreement to abide by the rules and regulations governing the seed certification in Oregon.

         Seed and Seedling crops will be inspected.

         Inspection of an annual crop combines aspects of seed and seedling crop into one.

      2) A seedling field will be checked for eligibility of Stock Seed, adherence to Land Requirements, potential Isolation problems, Prohibited Weeds and Field Management as well as location.

         Application for seedling inspection must be submitted immediately after planting and no later than 60 days after seeding.

      3) Seed Crop Application and Inspection: The grower must apply for a seed crop inspection before the specified deadline each year if a certified seed crop is to be harvested. A seed field will be checked for Eligibility, Isolation, Prohibited Weeds and Field Management.

b. Stock Seed

1) The grower must plant eligible varieties and of the proper class or generation. Documentary evidence of the seed source such as a certification tag, sales record, etc., must be furnished when applying for certification.

2) Four seed classes meeting or exceeding the standards of the Association of Official Seed Certifying Agencies used in seed certification; Breeder, Foundation, Registered and Certified.

a) Breeder Seed is the original source of all classes of certified seed. It is stock directly maintained and controlled by the originating or sponsoring plant breeder or institution and provides the direct source of Foundation Seed.

b) Foundation Seed (White Tag) is produced from field planted with Breeder seed. Oregon public varieties will be grown under supervision of, or contract with the Foundation Seed Project.

c) Registered Seed (Purple Tag) is produced from fields planted with Foundation seed. In some varieties there is no registered class.

d) Certified Seed (Blue Tag) is produced from fields planted with Registered Seed or Foundation in there is no registered class.

c. Land Requirements

The seed must be planted on clean land. The land must not have been previously planted to or have grown another variety or class of seed that might volunteer and affect genetic purity. Adding manure or other contaminating amendments may be a basis for not meeting land requirements.

d. Isolation

1) Isolation - All fields used for the production of certified seed must have the minimum specified isolation distances from fields of any other variety of the same species or closely related species unless of the same variety, generation and certified.

2) The Isolation Strip may be used to : 1. produce a crop of another species, 2. grow the same species but cut to prevent seed production, 3. grow the same species but harvest seed from the isolation strip separately and process this seed as uncertified.

e. Field Management and Inspection

1) Field Management Prior to Field Inspection

a) The field shall be in such condition that genetic purity shall be maintained.

b) Field or seedling identity shall be maintained throughout the life of the stand.

c) Rouging of objectionable weeds, other crops and off-type plants difficult to separate in cleaning should be done before inspection.

d) The certification inspector may refuse to approve a field for certification due to unsatisfactory appearance caused by weeds, insufficient growth, inadequate stand, disease, insect damage and any other condition which prevents thorough inspection or may reflect unfavorably upon the certification program.

e) The unit of certification is the entire field.

f) Evidence of seed-borne disease at time of field inspection or presence of seed-borne disease in the seed lot may be basis for rejection, reclassification or seed treatment.

g) The presence of smut balls in seed stock shall be basis for reclassification to a certified class.

2) Reinspection - A field that fails to meet the minimum field standards may be rejected subject to reinspection.

3) Basis for Refusal to Inspect - The Seed Certification Service reserves the right to return fees and refuse certification when:

a) The location of the field is such that inspection would be unduly expensive.

b) A grower fails to follow the rules governing certification.

c) Heavy weed infestation, lodging, etc., or storm, frost or other conditions beyond the control of the grower.

d) A field is harvested before certification.

e) The owner of the variety no longer wishes certification.

D. Time of Seeding

All of the following grass seed varieties may be "Carbon Planted" with the exception of Kentucky Bluegrass and Bentgrass.

1. Bentgrass: May be spring or fall planted. If planted in the fall, do so before September 15. If planted in the spring, do so in May. Calculate 5 lbs./acre, and 6 inch rows or broadcast.

2. Fine Fescue: Spring planted between April 15 and May 15. Calculate 3-5 lbs./acre and 6 inch rows. Fine Fescue may be carbon banded.

3. Kentucky Bluegrass: Spring planted between April 15 and May 15. Calculate 2 lbs./acre and 6 inch rows.

4. Perennial Ryegrass: Fall planted between September 15 and October 15. Calculate 5 lbs./acre and 12 inch rows.

5. Tall Fescue: Spring planted between April 15 and May 15. Calculate 4 lbs./acre and 18 inch rows.

6. Annual Ryegrass: Fall planted between September 15 and October 15. Calculate 20 lbs./acre and 6 inch rows.

7. Orchardgrass: Spring planted between April 15 and May 15. Calculate 4 lbs./acre and 18 inch rows.

E. Weeds and Their Control

The following is a list of various weeds found in grass seed production. The chemicals that are listed to control these weeds are ones that have been used in the past. Chemical controls are constantly changing and therefore, you should consult your local Extension Agent for updated information (refer to Appendix F and Appendix H).

1. Weeds Controlled by Broadleaf Weed Killers

a. Pineapple Weed (Matricaria matricarioides)
b. Red Sandspurry (Spergularia rubra)
c. Shepherds-purse (Capsella bursapastoris)
d. Parentucillia (Paretucillia lillosa)
e. Lambsquarters (Chenopodium alba)
f. Speedwell (Veronica persica)
g. Common Chickweed (Stellaria media)
h. Common Mullein (Verbascum thapsus)
i. Wild Carrot (Daucas carota)
j. Dog Fennel (Anthemis cotua)
k. St. Johnswort (Hypericum perfonatum)
l. Hairy Hawksbeard (Crepus setosa)
m. Tansy Ragwort (Sencio jacobaea)
n. Sheep Sorrel (Rumex acetosella)
o. Dandelion (Taraxacum officinale)
p. Common Yarrow (Achillea millefolium)
q. Smooth Hawksbeard (Crepis capillanis)
r. Corn Spurry (Spergala arvense)
s. Spotted Catsear (Hypochoeris radicata)
t. Curly Dock (Ramex crispus)
u. Wild Mustard (Brassica sp.)
v. Buckhorn Plantain (Polatogo)
w. Canada Thistle (Circium arvense)
x. Knotweed (Polygonum aviculare)
y. Wild Radish (Raphaninus)
z. Bedstraw (Galium sp.)
aa. Bur-Chervil (Antriscus-scandicina)
bb. Field Chamomile (Anthemis aivensis)
cc. Redroot Pigweed (Amaranthus retroflexis)
dd. Barnyardgrass (Echochola crusgati)
ee. Nightshade (Solarium nigruin)
ff. Common Groundsel (Senecio vulgaris)
gg. Prickly Lettuce (Lactuca serriola)
hh. Smartweed (Polygonum persicaria)

2. Weeds Controlled by Grass Weed Killers

a. Downy Chess (Bromus mollis)
b. Rattail Fescue (Festuca myuros)
c. Barbed Witchgrass (Panicum vulgare)

   d. Sweet Vernalgrass (Anthoxanthum oaoratum)
   e. Wild oat (Avena fatua)
   f. Wild Barley (Hordeum sp,)

3. Weeds Controlled by Spot Treatment

   a. Silver Hairgrass (Aira caryophyllea)
   b. Velvetgrass (Holcus mollis)
   c. Creeping Velvetgrass (Holcus lanatas)
   d. Mouse-ear Chickweed (Cerastium vulgatum)
   e. Tansy Ragwort (Senico jacobera)
   f. Mannagrass (Glyceria borealis)
   g. Sedge (Carex sp.)
   h. Quackgrass (Agropyron repens)
   i. Crabgrass (Digitaria sanguinalis)

F. Harvesting

Before the grass seed may be harvested, the process of removing the seed from the seed head, it must be swathed. This practice is done prior to harvesting the seed with the combine. The swathing process cuts a section of grass and leaves it as a row or a swath behind the swather. It is left there until the conditions are right for combining. Drying time varies and it is a very critical time in the grass seed business. Combining too early results in immature seeds as well as too much moisture present. Too much moisture in the seed can lead to overheating. Likewise, waiting too long, the seed may shatter from the seed head much more readily thus resulting in a significant amount of seed being lost. Moisture content should be around 12%. Most swathing is done at night because it is damper and the seed will not shatter so easily. Grass seed may also be swathed during the day if it is a very cool and damp day.

Swathing is the most common practice but, some producers perfer to combine their grass seed standing. Problems can arise with this practice such as shattering. Some grass varieties are more adapted to being combined standing, such as Bentgrass, but Fine Fescue varieties must be swathed because of their great tendency to shatter.

The following is a list of the grass seed varieties and their moisture content percentages for swathing:

1. Bentgrass: 22% moisture for swathing
2. Fine Fescue: 25-30% moisutre for swathing
3. Kentucky Bluegrass: 34% moisture for swathing
4. Perennial Ryegrass: 34% moisture for swathing
5. Tall Fescue: 44% moisture for swathing
6. Annual Ryegrass: 22% moisture for swathing
7. Orchardgrass: 44% moisture for swathing

G. Storing the Grass Seed

After combining the grass seed, it is taken from the field either by bulk or by sack. Many producers today use the bulk method. The seed is then stored until time to clean the seed. Whether the seed is stored by bulk or by sack, the producer must watch for (1) bugs, (2) over heating, and (3) mice, if the seed is stored for a long period of time.

Bentgrass has the longest shelf life of all grass seed varieties. In fact, Bentgrass has been known to have a "post harvest dormancy" and therefore goes dormant when stored after harvesting. When germination tests have been conducted, Bentgrass on the average does better one year after harvesting. Kentucky Bluegrass has a long shelf life like Bentgrass and Fine Fescue has the shortest with all other varieties somewhere in between Bentgrass and Fine Fescue.

WHAT INSECTS AND DISEASES ATTACK GROWING GRASS SEED?

A. Insects

Refer to Appendix G and Appendix H.

B. Diseases

Many things must be considered in order to effectively control diseases common to grass seed fields.

The first factor to consider is the prior years treatment of the field. This would include the history of crops, whether the field had or had not been burned and the chemical and fertilizer programs.

The second factor to consider is the proximity to untreated fields. A producer should consider if the adjoining fields are Bluegrass or Perennial Ryegrass, the maintenance of the other adjoining fields and the physical characteristics of each field such as moisture present, air drainage and temperature.

The third factor to consider is if the varieties are susceptable or nonsusceptable to disease and the varieties maturing dates. Along with the variety considerations, the species characteristics and susceptabilities should be considered.

The fourth factor to consider is the winter and spring weather patterns. Depending on the type of weather patterns can determine some disease problems that may arise.

The fifth factor to consider is the equipment available to spray the fields for the diseases that may occur.

The sixth factor to consider is the types of chemicals to use to control the disease problems. When considering the chemical possibilities, it is a good idea to consult the local Extension Agent or Field Representative. When working with chemicals be sure to follow all safety precautions as well as proper directions for effective results (refer to Appendix H).

FIELD BURNING

A. The Reason for Field Burning

The only feasible control for most diseases of annual and perennial grasses is the thermal treatment provided by field burning or other thermal field sanitizing. Development of chemical control of certain diseases is progressing. Control of weeds, which create problems of seed quality, is dependent on field burning to destroy crop residues which interfere with the activity of soil-applied herbicides and to kill most weed seeds. For the present, it appears that a thermal treatment for annual and perennial grasses is the only effective way to maintain seed yields and control diseases, weeds, insects and other problems which otherwise could wipe out the grass seed industry.

B. Cropping Alternatives

In most areas of the mid to southern Willamette Valley, soils are too dense and too saturated in the winter and spring to permit the growth of crops other than grasses. Other crops are available for production in the better-drained soil areas, but for the approximately 150,000 acres of poorly drained lands, there simply are no good alternatives unless both drainage systems and irrigation systems are widely deployed. With new techniques, drainage is a definite possibility but there are not drainage outlets for much of the land and the environmental impact of drainage on the water balance and on wildlife is unknown.

C. Burning Management and Air Pollution Control

Some systems of field burning result in less air pollution than others. Burning straw in stacks, backfire burning and burning large areas to create a tremendous updraft are examples of these systems. Improved burning management or the organization of districts to provide burning management will continue to reduce air pollution.

D. The Benefits of Burning

The primary reason for initiating field burning of grass seed fields was to control disease. However, there are other benefits:

1. Inexpensive removal of residue
2. Weed control
3. Stimulation of seed yield
4. Insect and rodent control
5. Quicker return of minerals to the soil
6. Easier crop establishment
7. Increases fertilizer efficiency
8. Reduced fire hazard

	August	September	October	November	December	January	February	March	April	May	June	July
Bentgrass	Harvest and remove crop residue ↓	Examine fields & make plans for fall weed control	Fertilize ↓				Check for Spring weed control problems ↓	Make plans for Spring fertilization and weed and disease control			Watch for proper harvest conditions ↓	
Annual Ryegrass	↓	Prepare ground for seeding	Fall weed control ↓				↓	↓			↓	
Perennial Ryegrass	↓	↓	↓				↓	↓			↓	
Orchard Grass	↓	Examine fields & make plans for fall weed control	↓				↓	↓			↓	
Kentucky Bluegrass	↓	↓	↓				↓	↓			↓	
Tall Fescue	↓	↓	↓				↓	↓			↓	
Fine Fescue	↓	↓	↓				↓	↓			↓	

Appendix A

EXTENSION SERVICE
Marion County Office

Oregon State University

Marion County Health & Service Bldg.
3180 Center Street NE,
Room 160
Salem, Oregon 97301 (503) 588-5301

January 1983

MARION COUNTY, OREGON

1982 ESTIMATED CASH RECEIPTS FROM FARM MARKETINGS

The attached estimates of cash receipts from marketing farm products in Marion County totaled $198,158,000. This amount, 5% above 1981, and the highest ever for any Oregon county, indicates the importance of Marion County's agriculture to our communities and our state.

Many cooperated in developing these estimates. Major contributors included individual growers, first handlers, lending agencies, farm and commercial warehouses, food processors, Oregon Crop and Livestock Reporting Service with USDA cooperating, OSU Extension Agricultural Economists, and Marion County Extension Agents.

Cash receipts, compared with 1981, are summarized as follows:

Small Fruits, Tree Fruits, Nuts	$ 16,696,000	+ 5%
Nursery, Greenhouse, Other Specialty Horticulture Crops (Bulb, Turf Sod, Mushrooms, Holly) Christmas Trees, Farm Forestry	42,978,000	+ 7%
Vegetables	36,595,000	- 1%
Grass and Legume Seeds	13,250,000	-18%
Grain and Forage Crops	17,026,000	+27%
Specialty Field Crops (Beet Seed, Potatoes, Hops, Mint, Dill, Vegetable and Flower Seeds)	23,575,000	0%
Livestock, Dairy, Poultry	49,968,000	+13%
	$ 200,088,000	+ 6%

Remember, these are gross receipts. The County's highly diversified agriculture typically shows gains and reductions, shifting to different enterprises from year to year. This was also true in 1982. Because of escalating costs, heavy investment costs, and relatively low prices received by growers, 1982 was a difficult year for much of Marion County agriculture.

May 1983 be a successful and propserous year for all!

Prepared by County Extension Agent
Ken Brown, Mike Gamroth, Gale Gingrich,
Robert McReynolds, Gene Pirelli,
Wayne Roberts, Wilbur Bluhm

Sincerely yours,

Wilbur L. Bluhm

Wilbur L. Bluhm
Marion County Extension Office

84

MARION COUNTY, OREGON
1982 ESTIMATED CASH RECEIPTS FROM FARM MARKETINGS

SMALL FRUITS

CROP	ACRES	YIELD LBS/A	TOTAL PRODUCTION (LBS)	AVERAGE PRICE/LB	CASH RECEIPTS
Strawberries	1,950	9,600	18,720,000	$ 0.415	$ 7,769,000
Red Raspberries	110	4,500	495,000	0.651	322.000
Black Raspberries	0	0	0	0	0
Evergreen Blackberries	500	8,000	4,000,000	0.12	480,000
Marion Blackberries	800	6,500	5,200,000	0.28	1,456,000
Boysenberries	490	4,000	1,960,000	0.30	588,000
Loganberries	335	4,400	1,474,000	0.33	486,000
Blueberries	140	6,000	840,000	0.65	546,000
Gooseberries	0	0	0	0	0
Currants	20	10,000	200,000	0.34	68,000
Elderberries	15	6,800	102,000	0.255	26,000
Grapes	60	6,000	360,000	0.35	126,000
			TOTAL SMALL FRUITS		$ 11,867,000

TREE FRUITS AND NUTS

CROP	ACRES	PER ACRE YIELD	TOTAL PRODUCTION	AVERAGE PRICE	CASH RECEIPTS
Apples	320	340 Bx	108,300 Bx	$ 4.50/Bx	$ 490,000
Sweet Cherries	1,900	1.7 T	3,200 T	380.00/T	1,216,000
Sour Cherries	125	2.0 T	250 T	320.00/T	80,000
Peaches	300	130 Bx	39,000 Bx	12.00/Bx	468,000
Bartlett Pears	120	13.3 T	1,600 T	125.00/T	200,000
Prunes & Plums	250	4.0 T	1,000 T	80.00/T	80,000
Filberts	3,600	0.8 T	2,880 T	780.00/T	2,246,000
Walnuts	100	0.55 T	55 T	900.00/T	49,000
			TOTAL TREE FRUITS AND NUTS		$ 4,829,000

MARION COUNTY, OREGON

1982 ESTIMATED CASH RECEIPTS FROM FARM MARKETINGS

SPECIALTY HORTICULTURAL AND FORESTRY CROPS

Nursery Crops (ornamental, fruit and nut trees; broad leaved evergreens; conifers; deciduous shrubs; herbaceous plants).	$ 13,820,000
Greenhouse Crops (potted plants, cut flowers, florist greens, bedding plants).	4,825,000
Christmas Trees	3,608,000
Other Specialty Crops (bulb crops, holly, mushrooms, turf sod, etc.)	19,975,000
Farm Forestry	750,000
	$ 42,978,000

VEGETABLES

CROP	ACRES	AVERAGE YIELD T/A	TOTAL PRODUCTION TONS	AVERAGE PRICE PER TON	CASH RECEIPTS
Processed Vegetables					
Beans, Snap	13,800	5.2	71,760	$170.00	$ 12,200,000
Table Beets	50	17.0	850	62.35	53,000
Broccoli Processed	850	7.9	6,700	360.00	2,412,000
Cabbage Processed	240	20.0	4,800	45.00	216,000
Carrots Processed	275	24.0	6,600	45.50	300,000
Cauliflower, Processed	1,670	7.0	11,690	250.00	2,923,000
Cucumbers	350	14.1	4,935	159.05	785,000
Peas, Processed	3,300	2.3	7,590	178.50	1,355,000
Squash-Pumpkin	300	21.7	6.500	100.00	650,000
Sweet Corn	18,300	9.2	168,350	74.00	12,460,000
Fresh Market Vegetables					
Onions	1,840	450 cwt.	830,000/cwt.	2.50/cwt.	2,075,000
All Other Fresh Market Vegetables					1,166,000
TOTAL VEGETABLE CROPS					$ 36,595,000

MARION COUNTY, OREGON

1982 ESTIMATED CASH RECEIPTS FROM FARM MARKETINGS

GRASS AND LEGUME SEEDS

CROP	ACRES	AVERAGE YIELD LBS/A	TOTAL PRODUCTION LBS	AVERAGE PRICE LBS	CASH RECEIPTS
Bentgrass	8,900	400	3,560,000	$ .80	$2,848,000
Kentucky Bluegrass	2,200	550	1,210,000	.50	605,000
Chewings Fescue	7,750	700	5,425,000	.42	2,280,000
Red Fescue	4,600	700	3,220,000	.42	1,352,000
Tall Fescus	600	630	378,000	.341	129,000
Annual Ryegrass	600	1,000	600,000	.15	90,000
Perennial Ryegrass	10,460	1,000	10,460,000	.38	3,975,000
Orchardgrass	1,300	1,000	1,300,000	.40	520,000
Crimson Clover	300	500	150,000	.247	37,000
Red Clover	2,300	350	805,000	.77	600,000
Hairy Vetch	100	500	50,000	.34	17,000
Common Vetch	400	1,200	480,000	.20	96,000
Austrian Peas	3,400	1,500	5,100,000	.105	536,000
White & Ladino Clover	250	400	100,000	1.40	140,000
Miscellaneous Grass and Legume Seeds					25,000
				TOTAL SEED CROPS	$ 13,250,000

SPECIALTY FIELD CROPS

CROP	ACRES	AVERAGE YIELD	TOTAL PRODUCTION	AVERAGE PRICE	% SOLD	CASH RECEIPTS
Potatoes	150	300 cwt/A	45,000 cwt	$ 4.50 cwt	93	$ 188,000
Mint for Oil	2,600	65 lb/A	169,000 lb	9.00/lb	100	1,521,000
Dill for Oil	50	60 lb/A	3,000 lb	7.00/lb	100	21,000
Hops	6,400	1,700 lb/A	10,880,000 lb	1.50/lb	100	16,320,000
Dry Beans	100	20.0 cwt/A	2,000 cwt	20.00 cwt	100	40,000
Sugar Beet Seed	2,920	3,250 lb/A	9,487,466 lbs	.43 lb	100	4,080,000
Vegetable and Flower Seed						1,405,000
TOTAL SPECIALTY FIELD CROPS AND FARM FORESTRY						$ 23,575,000

MARION COUNTY, OREGON

1982 ESTIMATED CASH RECEIPTS FROM FARM MARKETINGS

FORAGE CROPS

CROP	ACRES	AVERAGE YIELD	TOTAL PRODUCTION	AVERAGE PRICE	% SOLD	CASH RECEIPTS
Alfalfa	4,300	5.0 T/A	21,500T	$80.00T	50	$ 860,000
Hay	14,000	2.5 T/A	35,000T	55.00T	20	385,000
Corn Silage	4,000	22.0 T/A	88,000T	18.00/T	40	634,000
Grass and Grain Straw			12,000T	25.00/T	70	210,000
			TOTAL HAY CROPS			$ 2,089,000

GRAIN CROPS

CROP	ACRES	AVERAGE YIELD	TOTAL PRODUCTION	AVERAGE PRICE	% SOLD	CASH RECEIPTS
Wheat	48,000	75 bu/A	3,600,000 bu	$3.88/bu	98	$ 13,688,000
Barley	2,000	62 bu/A	124,000 bu	2.40/bu	87	258,000
Oats	7,500	100 bu/A	750,000 bu	1.60/bu	80	960,000
Rye	200	50 bu/A	10,000 bu	2.70/bu	89	24,000
Corn	50	90 bu/A	4,500 bu	2.22/bu	70	7,000
				TOTAL GRAIN CROPS		$ 14,937,000

MARION COUNTY, OREGON

1982 ESTIMATED CASH RECEIPTS FROM FARM MARKETINGS

LIVESTOCK, DAIRY AND POULTRY PRODUCTS

	INVENTORY NO. HEAD	AVERAGE PRODUCTION	TOTAL PRODUCTION	PRICE	CASH RECEIPTS
Cattle and Calves	40,000				$ 6,248,000
Swine	11,000		16,500 hd		1,924,000
Sheep and Lambs	18,000				654,000
Wool	16,000	6.4 lbs/hd	102,000 lbs	.402/lb	41,000
Mink	10,500	3.8 pelts/hd	39,900 pelts	37.00/pelt	1,476.000
Honey & Beewax	4,800				120,000
Horses and Mules	4,700				200,000
Rabbits	900		22,500 hd	2.50/hd	56,000
TOTAL LIVESTOCK					$ 10,719,000
Dairy Products	11,700	153 cwt/cow	1,729,000 cwt	13.80/cwt	$ 24,613,000
TOTAL DAIRY PRODUCTS					$ 24,613,000
Farm Chickens	885,000		500,000 hd	.32/hd	$ 158,000
Broilers			2,200,000 hd	1.60/hd	3,520,000
Chicken Eggs	900,000	21 doz/hd	18,900,000 doz	.59/doz	10,928,000
Miscellaneous					30,000
TOTAL POULTRY AND POULTRY PRODUCTS					$14,636,000
TOTAL LIVESTOCK, DAIRY, AND POULTRY					$49,968,000

FS 260
August 1981

Growing Kentucky Bluegrass for Forage

Area of Adaption

Kentucky bluegrass *(Poa pratensis)*, is grown extensively in the middle and northwestern sections of the United States, and in parts of Oregon, Washington, and Idaho. It has a wide adaption for soils, but is best suited to well-drained soils of limestone origin. Kentucky bluegrass can be grown in irrigated pastures in central, south-central, and northeastern Oregon. However, because it has lower productivity than other perennial grasses in most areas of the state, it is recommended for use only in the Klamath Falls area of Oregon.

Primary Use

Kentucky bluegrass is used primarily in irrigated pastures in combination with white clover. This combination typically has been associated with horse pastures, but it can be used effectively with beef or sheep as well. Kentucky bluegrass is a long-lived perennial that produces a dense sod from rhizomes. Although Kentucky bluegrass is relatively low in production in midsummer, yields can be increased by adequate irrigation and an ample supple of nutrients. In many cases, however, other grass forage species will be superior to bluegrass for forage production.

Varieties

Kentucky bluegrass is apomictic in nature. That is, seed may be produced without fertilization. For this reason a wide range of variability is present in this grass species. "Common" Kentucky bluegrass is a general-purpose grass for pasture or lawn use. Low-growing types have been selected for turf suitability. Of these, Kenblue, Park, and Troy were selected for reduced management requirements and are suitable for pastures. Superior cultivars have not been developed specifically for pasture or forage purposes. This may explain why greater forage production is often obtained with other forage grasses.

KENTUCKY
BLUEGRASS

Establishment

Seedings can be made in the spring or late summer in irrigated pasture. Seed should be planted ¼ to ½ inch deep in well-prepared soil that is firm below a depth of 2 inches.

Use	Precipitation	Kentucky bluegrass seeding rate	Companion species	Companion species seeding rate
	Inches	*Lbs/A*		*Lbs/A*
Pasture	Irrigated	5-10	White clover	2-3
		5-10	Birdsfoot trefoil	6

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Fertility and pH Requirements

Kentucky bluegrass requires a high level of fertility for maximum production. It does best on soils of near neutral to alkaline pH (6.5 to 8.0) as long as those soils are not saline or sodic. Adequate liming and fertility should be provided for companion legumes in order to produce a good stand and reduce competition from weeds. Specific recommendations based upon soil test data may be found in OSU Fertilizer Guide 21.

Management

For most productive pastures, Kentucky bluegrass pastures should be kept between 2 and 6 inches. Overgrazing of bluegrass pastures will result in poor root and rhizome development, while undergrazing will result in excess grass competition. Proper grazing management, in addition to providing adequate levels of nutrients and a proper soil pH, will encourage good growth of companion legumes in clover-grass pastures. If clovers disappear from clover-grass pastures, they may be reintroduced by pasture renovation techniques.

If birdsfoot trefoil is used as the legume with Kentucky bluegrass, rotational grazing should be used because trefoil is sensitive to close grazing. A recovery period that allows birdsfoot trefoil to initiate flowering, followed by grazing to a height of 2 to 4 inches, will encourage a long-lived grass-legume pasture.

By David B. Hannaway, Extension agronomist, and William S. McGuire, professor of agronomy, Oregon State University.

FS 262
June 1981

Growing Perennial Ryegrass for Forage

Area of Adaption

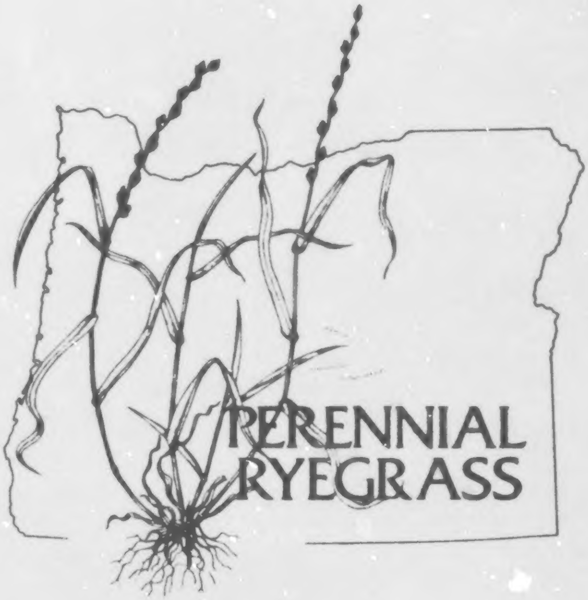
Perennial ryegrass *(Lolium perenne)* is a major forage grass which is used in cool, temperate climates throughout the world. In Oregon, it is adapted to areas west of the Cascade Mountains but is less winter-hardy than orchardgrass or tall fescue. For this reason it is not often recommended for use east of the Cascades.

Primary Use

Perennial ryegrass is commonly used for pasture and hay in sheep, dairy, and beef production. It is most often used in combination with white clover or subclover. When ryegrass is seeded with either of these clovers, the mixed pasture makes an excellent quality feed for the grazing animal. Perennial ryegrass does not persist as long as some other pasture species, but it is quite satisfactory for several years. Tetraploid ryegrasses have been developed recently for use as an ingredient of short-rotation dairy pastures.

Varieties

Linn is a relatively long-lived variety that has been used successfully in Oregon for many years. Astor is a variety that has been used for dairy pastures on the Oregon coast. Several proprietary varieties are also available from private seed companies.



Recent developments in plant breeding have resulted in tetraploid ryegrass varieties. Autotetraploids (produced by duplication of the chromosome sets from one species) will have perennial characteristics. However, allotetraploids (produced by combining chromosomes from two species—perennial and annual) are likely to be short-lived and should only be used in short-rotation pastures (2-4 years).

Use	Precipitation	Perennial ryegrass seeding rate	Companion species	Companion species seeding rate
	Inches	*Lbs/A*		*Lbs/A*
Pasture	Irrigated	10-12	White clover	2-3
	> 60	10-12	White clover	2-3
	40-60	10-12	White clover or subclover	2-3 7
	< 40	10	Subclover	7-10
Short-rotation pasture	> 40 or irrigated	(tetraploid) 10-12	White clover plus red clover	2 4

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Establishment

Perennial ryegrass may be fall seeded in areas with relatively mild winters. Seed should be planted in late summer before the fall rains begin. Spring seeding is possible where adequate moisture is available for seedlings to develop before the arrival of dry summer conditions. Seed should be planted ¼ to ½ inch deep in a well-prepared seedbed.

Fertility and pH Requirements

Perennial ryegrass requires high fertility levels for good production. If ryegrass is grown in combination with a nitrogen-fixing legume, it will not be necessary to apply nitrogen, but adequate levels of phosphorus and sulfur should be provided. Best growth will occur between pH 5.5 and 6.5. Specific recommendations based upon soil data are available in OSU Fertilizer Guides 1, 4, 16, and 58, depending upon the location and use of the pasture.

Management

In order to obtain the highest quality forage, clover-grass pastures should be grazed between 2 and 6 inches high to prevent the grass from shading the clover. Pastures are often grazed early in the season, and some areas are reserved for hay when growth exceeds the demand. For highest quality, hay should be cut when the inflorescence is emerging from the leaf sheath and certainly before flowers begin to shed pollen.

Spring application of nitrogen will stimulate early growth of the grass but will reduce the amount of clover in the pasture. Clovers are favored by continued close grazing (to 2 inches), adequate levels of phosphorus and sulfur, and no nitrogen applications. If clovers disappear from the pasture, they may be re-established by renovation techniques.

By David B. Hannaway, Extension agronomist, and William S. McGuire, professor of agronomy, Oregon State University.

Appendix B

FS 263
June 1981

Growing Tall Fescue for Forage

Area of Adaption

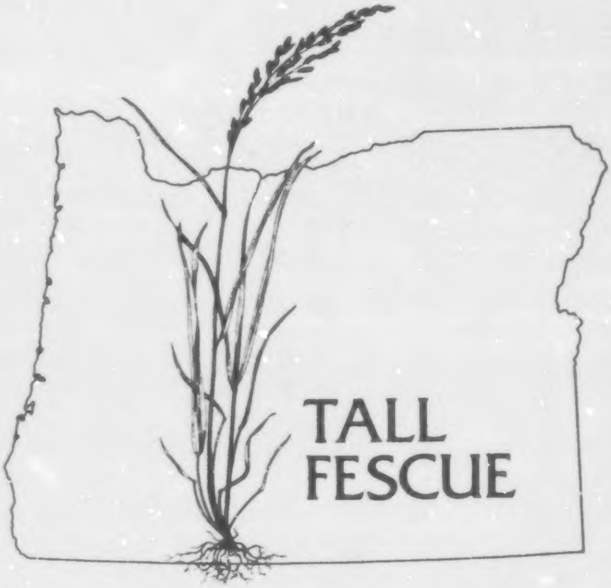
The extensive and rapid acceptance of tall fescue *(Festuca arundinacea)* since 1950 is a result of its wide adaption and valuable qualities as a pasture grass. Tall fescue is adapted to a wide range of climatic conditions and is heavily used in the central and southeastern United States. It is the only cool-season grass that can persist in many parts of the south.

Large quantities of tall fescue are produced for seed in Oregon, in addition to its use as a pasture grass throughout Washington and Oregon. Tall fescue, one of the most drought-tolerant forage grasses, is also tolerant of poor drainage, alkalinity, and salinity.

Primary Use

Tall fescue is used widely for forage, turf, and conservation purposes. It is the predominant cool-season grass in many states, where it is used extensively in pastures. Tall fescue produces most abundantly under irrigation and high fertility. It is tolerant of continuous close grazing and is superior to many other cool-season grasses in livestock-carrying capacity.

Tall fescue also can be used as a hay crop. When used for hay, tall fescue should be harvested when the first seed heads begin to appear.



Use	Precipitation	Tall fescue seeding rate	Companion species	Companion species seeding rate
	Inches	*Lbs/A*		*Lbs/A*
Pasture	< 40	15	Subclover	7
	40-60	15	Subclover	7
		15	White clover	2-3
	> 60	15	Big trefoil	2
		15	White clover	2-3
Wetland or irrigated pasture		15	White clover	2-3
		15	Birdsfoot trefoil	6
Hay	40-60	12	......	......
		12	Red clover	8
	> 60	12	White clover	2-3

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Varieties

Fawn and Alta are varieties of tall fescue that have been recommended in Oregon for many years. Kentucky 31 and Demeter have produced well in recent variety test evaluations. Kenhy, a ryegrass-fescue hybrid with improved palatability, has also performed well in these tests.

Establishment

When established, tall fescue has vigorous growth, but its seedling growth and establishment are somewhat slow. Therefore, a clean, firm seedbed is most desirable. Seed should be planted from ¼ to ¾ inch deep, depending upon soil conditions. Tall fescue can be seeded either in late summer (before the fall rains start) or in spring. Better legume stands, however, usually are obtained with spring planting.

Fertility and pH Requirements

Tall fescue does best on soils of high fertility, but it is not difficult to establish under rather adverse soil conditions. It will establish on soils of low pH and will do well on a variety of soil types. Liming and fertilizing, on the basis of soil test information, are essential for a good stand of legume and will be satisfactory for good tall fescue growth. Specific recommendations may be obtained from OSU Fertilizer Guides 1, 16, 28, and 58.

Management

Since tall fescue is rather slow to establish, new stands can be seriously damaged by overgrazing or grazing too soon. However, close grazing of well-established stands is a good management practice. Tall fescue will withstand heavy grazing for short periods. Under irrigation and a rotational system of grazing, tall fescue recovers well. For best production and longevity, however, tall fescue should not be grazed closer than 2 inches.

The addition of a legume to tall fescue plantings increases the palatability and nutritive value of the pasture. Legume addition, however, makes managing these pastures more difficult as the legume will be selectively grazed. Unless livestock are forced to use the tall fescue through rotational grazing, the legume will be removed by overgrazing.

By David B. Hannaway, Extension agronomist, and William S. McGuire, professor of agronomy, Oregon State University.

Appendix B

FS 261
June 1981

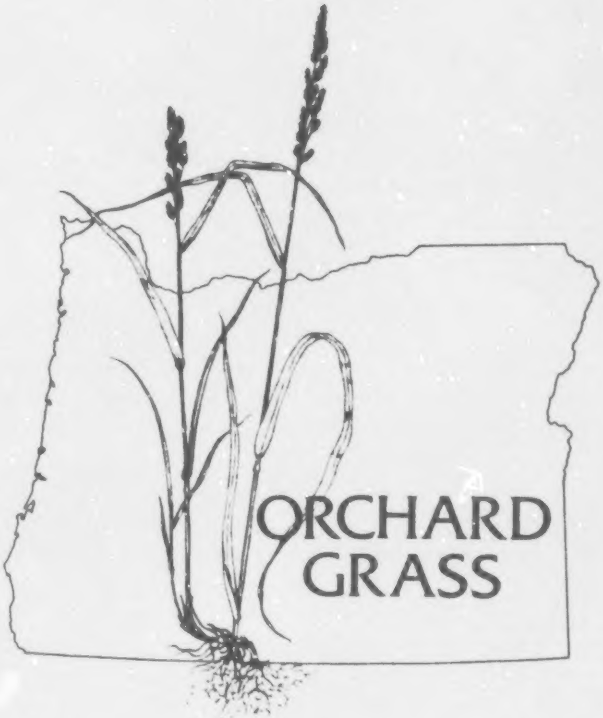
Growing Orchardgrass for Forage

Area of Adaption

Orchardgrass *(Dactylis glomerata)* is distributed through much of the northeastern and north-central United States and in the high rainfall and irrigated regions of the western mountains. It is often found growing along roadsides and in waste areas. Its tolerance of shady places in orchards undoubtedly led to its most widely known common name. Orchardgrass is known as "cocksfoot" in Europe, New Zealand, and Australia. This name was derived from the shape of its inflorescence.

Primary Use

Orchardgrass is used primarily as a hay or pasture crop and in combination with various legumes. It is a highly productive grass with a good production distribution throughout the year when maintained under high fertility levels. At high levels of nitrogen (without legumes) orchardgrass is among the most productive cool-season grasses. Orchardgrass is more tolerant of heat and drought than perennial ryegrass, timothy, or Kentucky bluegrass but less so than tall fescue. Winter production of orchardgrass is usually less than that of perennial ryegrass or tall fescue as orchardgrass is more affected by frost.



Varieties

Orchardgrass breeders have concentrated on developing varieties that mature later than com-

Use	Precipitation	Orchardgrass seeding rate	Companion species	Companion species seeding rate
	Inches	*Lbs/A*		*Lbs/A*
Pasture	> 60	10-12	White clover	2-3
	40-60	10-12	White clover	2-3
		10-12	Subclover	7
	< 40 or	10-12	Subclover	7-10
	irrigated	10-12	White clover	2-3
		7	Birdsfoot trefoil	6
Hay	40-60	5-6	Alfalfa	10
		12-15	-------	-------

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mon orchardgrass, are more productive, and more resistant to disease. Potomac is an early variety, Pennmead and Sterling are intermediate, and Pennlate and Latar are late maturing varieties. When used in combination with alfalfa, late maturing varieties are preferred to better coincide with the harvest date of alfalfa.

Establishment

When used in its area of adaption, orchardgrass is easily established. Orchardgrass can be established in early spring or late summer. Seeding rates and suggested combination species are shown in the table on page 1. The seedbed should be loose on top and firm below a depth of 2 inches. Seed should be planted ½ inch deep. If clover is mixed with orchardgrass, a planting depth of ¼ inch is sufficient. The use of a press wheel or cultipacker will help to ensure stand survival when orchardgrass is planted on a dry seedbed. Seedling growth may be retarded by inadequate levels of phosphorus in the soil.

Fertility and pH Requirements

If used without a legume, orchardgrass is very responsive to nitrogen fertilization. Yield responses to phosphorus and potassium fertilization have also been demonstrated for orchardgrass. Best growth will occur between pH 5.5 and 6.5 as orchardgrass is less tolerant of soil acidity than many other pasture grasses. Specific recommendations on fertilizer application based upon soil test information are found in OSU Fertilizer Guides 1, 16, 28, and 58.

Management

Highest yields of good-quality forage are obtained when orchardgrass hay is cut between head emergence and early bloom. Delaying harvest an additional 2 weeks will decrease aftermath harvest by one-fourth in addition to reducing the quality of hay cut at a late stage of maturity. Orchardgrass stands become thin and clumpy when first growth is cut late. However, stand longevity is not adversely affected by late cutting.

Regrowth of orchardgrass depends upon photosynthetic activity and carbohydrate reserves. When root reserves are high, close cutting or grazing does not adversely affect the stand. However, when reserves are low, close cutting is a severe management practice. Thus, cutting several times at ground level or continuous close grazing almost always results in serious stand injury. Injury also may result from burning in areas where excess forage is removed in this way (in late summer) to allow subclover seedlings to become established during the fall.

When planted in combination with orchardgrass, clover is favored by close clipping or grazing because it receives less shading from the grass. Adequate levels of phosphorus, potassium, and sulfur also favor the clover in a mixed clover-grass pasture. The application of nitrogen, however, favors the grass and may result in the disappearance of clover from the pasture.

By David B. Hannaway, Extension agronomist, and William S. McGuire, professor of agronomy, Oregon State University.

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FG 47
Revised June 1979

TURF GRASS

(Oregon)

Grasses require adequate fertilization to provide color, promote good root development, and to stimulate new leaf and crown formation. Nutrients removed by clippings and leaching must be replaced. Fertilizer requirements are modified by temperature, moisture, grass variety, use being made of turf, clipping disposal, and the general level of maintenance.

NITROGEN (N)

Grasses require large amounts of N for desirable growth. This element is leached by rainfall and is often difficult to store in the soil.

Soluble N fertilizers may cause grass burning if used at rates above 1 lb N/M (1,000 sq. ft.). Rates as high as 2 lb N/M may be used on dormant turf or during cooler periods. Applications should be made to dry turf and grass should be immediately irrigated to prevent foliar damage from the higher rates of soluble fertilizers.

Changes in color of the grass from blue green to yellow green can be the best guide for timing of N applications. Intensively managed areas may require applications as frequent as once every 30 days or even more frequently during the peak growing season. Avoid heavy applications prior to anticipated heavy traffic on athletic areas. Turf receiving only minimal care may require only one late summer and one spring application.

Nitrate-containing fertilizers such as calcium nitrate or ammonium nitrate give the fastest response when soils are cold.

Organic fertilizers release N more slowly and provide more uniform grass growth. They are also useful for summer applications because of less likelihood of burning damage during high temperature compared to chemical fertilizers. They should be used at rates of 2 to 4 lb N/M. Their response during cold weather is very poor because their conversion to readily available N is slow at low temperatures.

Urea formaldehyde or Isobutylidene Diurea (IBDU) fertilizers will release N over a 6 month period, but because of slow N release, these fertilizers must be applied at higher rates to provide an adequate amount of available N. Initial rates of 6 lb N/M followed by twice yearly rates of 4 lb N/M are required for effective long-lasting response.

PHOSPHORUS (P)

P is important for root growth and is especially important for young turf. Annual applications of 2 lb P_2O_5/M are sufficient. The relationship between P_2O_5 and P is explained under the section on "New Plantings". P moves very slowly in soil and should be applied before heavy rains or irrigations for maximum response. P is not readily leached from soils. No response on established turf is expected on sites having OSU soil test values above 45 ppm P in Western Oregon or 30 ppm in Eastern Oregon. For suppression of annual bluegrass, P_2O_5 application should not exceed 1 lb/M.

POTASSIUM (K)

Turf grasses require large amounts of K, especially when clippings are removed. K fertilizer is similar to N fertilizer with respect to danger of foliage burning. It is also adsorbed on clay and organic matter and thus not readily leached from soils containing these constituents. One lb of K_2O/M is the maximum single application. The relationship between K_2O and K is explained under the section on "New Plantings". The total of N plus K_2O should not exceed 2 lb/M for any one application. No response to K on established turf is expected on sites having OSU soil test values above 250 ppm K.

SULFUR (S)

Small amounts of S are required by turf. Exact requirements are not known. Many mixed fertilizers provide ample S. One lb S/M per year should be sufficient. Annual bluegrass can be suppressed with a total annual application of 3 lb S/M.

IRON (Fe)

Fe deficiency may develop during high temperatures. The symptoms are pale yellow leaf discoloration which cannot be corrected by N applications. Foliar applications of chelated Fe or ferrous ammonium sulfate applied according to manufacturers' directions are the best sources of Fe. Some turf fertilizer mixtures contain trace amounts of Fe.

LIME

Grasses grow over a wide range of soil pH. Adjustments in pH often improve availability of other nutrients, alter grass reaction to disease, and reduce the development of thatch. Elemental S, iron sulfate, and aluminum sulfate can be used to lower alkalinity in soils.

Liming of soils with pH lower than 5.8 may be desirable. For bluegrass turf, lime should be applied to soils with pH below 6.3.

The desirable range of calcium:magnesium ratio by OSU soil test is from 2:1 to 12:1. Dolomitic limestone should be applied when there is more than 12 times as much calcium than magnesium. In all other cases, ground limestone should be used to increase the soil pH.

Lime is most effective when incorporated into the soil prior to seeding. The rate of application of lime will depend on the type of soil and the extent to which the pH is to be increased.

MIXED FERTILIZERS

Many types and grades of fertilizers are available for turf grass purposes. Requirements of the grass are often most nearly met by formulations supplying annual $N-P_2O_5-K_2O$ ratios of 5-1-2, 4-1-2, 3-1-2 or multiples thereof.

APPLICATION TECHNIQUES

Uniform application is absolutely necessary to avoid foliar or tissue burn from the high rates suggested. Hand spreading is usually unsatisfactory. Small spreaders should be adjusted so that two or three coverages are required to spread the material over the area. By going in different directions with each coverage, skips and overlaps will not be apparent.

Always make sure the spreader is moving when any fertilizer is falling from it. Rotary spreaders are best adapted to odd shaped turf areas but may throw material onto adjacent walks and flower beds. Apply fertilizer only when turf is dry.

When using higher rates of soluble nitrogen and potassium, foliar burn can be alleviated by immediate watering of the turf. Soluble materials can be applied through the irrigation system to minimize burning. The fertilizer response will follow the pattern of water dispersal.

NEW PLANTINGS

Obtain an OSU soil test through the County Extension Office. Incorporate the following materials to a depth of 2 to 6 inches during seedbed preparation prior to seeding.

If OSU soil test reads:		Apply this amount lb/M (1,000 sq. ft.)	
pH	above 7.8	S	10[1]
	7.2 to 7.8		5[1]
	6.3 to 7.2		none
	5.8 to 6.3	Lime	100[2]
	5.3 to 5.8		150
	below 5.3		200
K (ppm)	200 to 300	K_2O	1
	150 to 200		2
	below 150		3
P (ppm): For Western Oregon	below 45	P_2O_5	1
P (ppm): For Eastern Oregon	below 30	P_2O_5	1

Note: The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

Note: The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by 0.83 to convert to K.

[1] Not required for blue grass.

[2] For blue grass only.

1 to 2 lb N/M should be incorporated with the above materials. Additional broadcast applications of N at 1 lb/M should be made as shown by poor grass color.

Where S is not applied in the above treatments, 1 lb S/M should be applied.

CONVERSION TO METRIC UNITS

In this FG, rates of fertilizer application are expressed in pounds per 1000 square feet (lb/M). In order to convert lb/M to kilograms per 100 square meters (kg/100 m^2), multiply lb/M by 0.5. Thus 2 lb/M = 1 kg/100 m^2.

The P, K, Mg, B, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Norman Goetze, Wilbur Bluhm, and Hugh Gardner, Cooperative Extension Service, Oregon State University, Corvallis, Oregon. Reviewed by a committee of Oregon County Extension Agents.

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FG 44
Revised March 1982

Blue Grass Seed

(Western Oregon—West of Cascades)

Good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended varieties, selection of adapted soils, weed control, disease and insect control, good seed bed preparation, proper seeding methods, and timely harvest.

Recommended soil sampling procedures should be followed in order to estimate fertilizer needs. The Oregon State University Extension Service agent in your county can provide you with soil sampling instructions, soil sample bags, and information sheets.

NITROGEN (N)

Liberal amounts of available N are required for optimum yields of blue grass seed.

On new seedings, place 20-40 lbs N/A near the seed. At least 1 inch of soil should separate the seed and fertilizer.

On established stands, a total annual application of 100 to 120 lbs N/A is suggested.

Apply 20 to 30 lbs N/A in the fall. An adequate supply of N in the fall stimulates early tiller development important to optimum seed production. Apply 70 to 100 lbs N/A during March.

The application of nitrate N to wet soils can result in the loss of N through reduction of nitrate.

PHOSPHORUS (P)

Soil testing should be used to evaluate the need for P fertilization.

On new seedings, when the OSU soil test for P is below 30 ppm, place 30 lbs P_2O_5/A near the seed. At least 1 inch of soil should separate the seed and fertilizer. The application rate should be increased by 50% when P is broadcast rather than placed near the seed.

On established stands, *P should be broadcast in the fall.*

If the OSU soil test for P reads (ppm)	Apply this amount of phosphorus (P_2O_5)-lbs/A
0 to 15	40 - 60
15 to 25	30 - 40
Over 25	None

POTASSIUM (K)

Soil testing should be used to evaluate the need for K fertilization.

On new seedings, when the OSU soil test for K is below 100 ppm, place 25 lbs K_2O/A near the seed. At least 1 inch of soil should separate the seed and fertilizer. The K application rate should be increased by 50% where K is broadcast.

On established stands, *K should be broadcast in the fall.*

If the OSU soil test for K reads (ppm):	Apply this amount of potash (K_2O)-(lbs/A)
0 to 100	60
Over 100	None

SULFUR (S)

Include 10-15 lbs/A of S in the annual fertilizer program for blue grass. S is sometimes contained in fertilizers used to supply other nutrients such as N, P, and K, but may not be present in sufficient quantity.

Plants absorb S in the form of sulfate. Fertilizer materials supply S in the form of sulfate and elemental S.

Elemental S must convert to sulfate in the soil before the S becomes available to plants. The conversion of elemental S to sulfate is usually rapid for fine ground (less than 40 mesh) material in warm moist soil.

S in the sulfate form can be applied at planting time. Some S fertilizer materials such as elemental S and ammonium sulfate have an acidifying effect on soil.

The S requirements of blue grass can be provided by:

1. The annual application of 10-15 lbs S/A in the form of sulfate or as fine ground (finer than 40 mesh) elemental S. Elemental S will not be available to plants until the soil warms up.
2. Applying 30-40 lbs S/A as sulfate or fine ground elemental S every second year.
3. Applying coarser ground elemental S at higher rates and less frequently.

OTHER NUTRIENTS

Responses of blue grass to nutrients other than those discussed in this guide have not been observed in Oregon.

LIME

Blue grass has responded to applications of lime in experiments conducted on acid soil in the Willamette Valley.

The application of lime is suggested when the soil pH is below 5.8 or the soil test for calcium (Ca) is below 5 meq Ca/100g. Lime should be worked into the seedbed at least several weeks before seeding. The amount of lime required is based on an SMP lime requirement test.

If the OSU SMP buffer test for lime reads:	Apply this amount of lime (T/A):
Below 5.5	4 - 5
5.5 - 5.8	3 - 4
5.8 - 6.1	2 - 3
6.1 - 6.5	1 - 2
over 6.5	0

The suggested liming rate is based on 100 score lime. Liming materials should be checked for score.

A lime application is effective over several years.

The use of N fertilizers for grass seed crops will tend to increase soil acidity (decrease soil pH). This should be considered in establishing or renovating perennial grass seed fields.

The surface application of lime to established seed fields could increase the soil pH in the surface one-half inch of soil and thereby increase the possibility of N loss from ammonium N and urea due to volatilization. Also, broadcasting lime on established stands of perennial grasses is not as effective as mixing lime with the soil.

Evaluate the soil acidity problem before making new plantings. The lime application should allow for some decrease in soil pH during the life of a perennial stand of grass.

Some soils may have a fairly high OSU SMP buffer value (over 6.2) and a low pH (below 5.3). This condition can be caused by the application of acidifying fertilizer. In this case the low pH value is temporary and the pH of the soil will increase as the fertilizer completes its reaction with the soil. This temporary "active" acidity from fertilizer is encountered following recent applications of most nitrogen fertilizer materials. Acidifying fertilizers also have a "long term" acidifying effect on soil which is cumulative and leads to lower OSU SMP buffer readings.

Sandy soils to which fertilizers have not been recently applied sometimes record low pH and high SMP buffer values. In such cases, a light application of lime (1 to 2 T/A) should suffice to neutralize soil acidity.

For acid soils low in Mg (less than 0.5 meq Mg/100g of soil) one ton/A of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

The P, K, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Thomas Doerge, Department of Soil Science; Hugh Gardner and T. L. Jackson, Extension Soil Scientists; and Harold Youngberg, Extension Agronomist; Extension Service and Agricultural Experiment Station, Oregon State University, Corvallis, Oregon.

OREGON STATE UNIVERSITY
EXTENSION SERVICE

Oregon State University Fertilizer Guide for

Extension Service, Oregon State University, Henry A. Wadsworth, director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Extension invites participation in its programs and offers them equally to all people.

FG 5
Revised February 1982

ANNUAL RYEGRASS SEED

(Western Oregon—West of Cascades)

Most of the annual ryegrass is produced on Dayton soils (white land) and all of the annual ryegrass fertilizer experiments have been carried out on these soils. The following recommendations are for annual ryegrass grown on Dayton soils.

Good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended varieties, weed control, disease and insect control, good seed bed preparation, proper seeding methods, and timely harvest.

Recommended soil sampling procedures should be followed in order to estimate fertilizer needs. Your county agent can provide you with soil sampling instructions, soil sample bags, and information sheets.

NITROGEN (N)

Liberal amounts of available N are required for optimum yields of annual ryegrass seed.

Fall application

Apply 20 lbs of N/A in the fall at planting time. A light fall application is important to promote seedling vigor. For fields which are pastured, higher rates of fall applied N produce more feed.

Grazing annual ryegrass fields may provide an additional source of income. Sheep grazing at moderate to heavy stocking rates from the start of spring growth (mid-February) through early April has not reduced seed yield. Shorter duration of grazing or lower stocking rates have not increased seed yields.

Spring grazing of annual ryegrass fields will increase the number of seed heads; however, the delayed heading will result in reduced seed bearing capacity per head. Thus the yield components are balanced and seed yield is maintained. There is no effect on germination or seedling vigor.

Spring application

Apply 80 to 100 lbs of N/A between March 1 and April 30. Applications of N can be made through mid-May if soil moisture remains adequate. Do not make spring applications of N until grazing has been completed.

N losses due to leaching, denitrification, and surface water runoff can be reduced by delaying N application until no standing water remains on the field.

PHOSPHORUS (P)

Soil testing should be used to evaluate the need for P fertilization.

Phosphorus should be placed near the seed in the fall at planting time.

If the OSU soil test for P reads (ppm)	Apply this amount P_2O_5 (lb/A)
0 to 15	40-60
15 to 25	30-40
over 25	None

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

POTASSIUM (K)

Soil testing should be used to evaluate the need for K fertilization.

If the OSU soil test for K reads (ppm)	Apply this amount K_2O (lb/A)
0 to 100	60
over 100	None

K should be placed near the seed at planting time or broadcast and worked into the seedbed prior to planting. Not more than 30 to 40 lbs K_2O/A should be placed near the seed.

SULFUR (S)

Include 10-15 lbs/A of S in the annual fertilizer program for annual ryegrass. S is sometimes contained in fertilizers used to supply other nutrients such as N, P, and K but may not be present in sufficient quantity.

Plants absorb S in the form of sulfate. Fertilizer materials supply S in the form of sulfate and elemental S.

Elemental S must convert to sulfate in the soil before the S becomes available to plants. The conversion of elemental S to sulfate is usually rapid for fine ground (less than 40 mesh) material in warm moist soil.

S in the sulfate form can be applied at planting time. Some S fertilizer materials such as elemental S and ammonium sulfate have an acidifying effect on soil.

The S requirements of annual ryegrass can be provided by:

1. The application of 10-15 lb/A (15-20 kg/ha) of S in the form of sulfate at planting time.
2. Applying 30-40 lb/A (35-45 kg/ha) of S as fine ground elemental S the preceding year.
3. Applying coarser ground elemental S at higher rates and less frequently.

OTHER NUTRIENTS

Responses of annual ryegrass to nutrients other than those discussed in this guide have not been observed in Oregon.

LIME

The application of lime is suggested when the soil pH is below 5.5. Lime should be worked into the soil at least several weeks before seeding. The amount of lime required is based on an SMP lime requirement test.

If the OSU SMP Buffer test for lime reads:	Apply this amount of lime (T/A)
below 5.2	4-5
5.2-5.5	3-4
5.5-5.8	2-3
5.8-6.2	1-2
over 6.2	0

The suggested liming rate is based on dry 100 score lime. Liming materials should be checked for moisture content and score.

A lime application is effective over several years.

The surface application of lime where minimum tillage is practiced could increase the soil pH in the surface one-half inch of soil and thereby increase the possibility of N loss from ammonium N and urea due to volatilization. Broadcasting lime is not as effective as mixing lime with the soil.

The use of N fertilizers for grass seed crops will tend to increase soil acidity (decrease soil pH). This should be considered in minimum tillage management of annual ryegrass.

Evaluate the soil acidity problem when renovating or making new plantings. The lime application should allow for some decrease in soil pH during the minimum tillage period.

Some soils may have a fairly high OSU SMP buffer value (over 6.2) and a low pH (below 5.3). This condition can be caused by the application of acidifying fertilizer. In this case the low pH value is temporary and the pH of the soil will increase as the fertilizer completes its reaction with the soil. This temporary "active" acidity from fertilizer is encountered following recent applications of most nitrogen fertilizer materials. Acidifying fertilizers also have a "long term" acidifying effect on soil which is cumulative and leads to lower OSU SMP buffer readings.

For acid soils low in Mg (less than 0.5 meq Mg/100g of soil) one ton/A of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

P, K, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

These recommendations are based on experiments conducted by Harold Youngberg and William C. Young III, Crop Science Department, Oregon State University, and T. L. Jackson, Oregon Agricultural Experiment Station, and observations of growers' results.

Prepared by E. Hugh Gardner and T. A. Doerge, Soil Science Department; and Harold Youngberg, Crop Science Department, Oregon State University, Corvallis, Oregon. Reviewed by a committee of Western Oregon Extension agents.

Fertilizer Guide

PERENNIAL RYEGRASS

(Western Oregon—West of Cascades)

FG 46
Revised April 1982

Good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended varieties, selection of adapted soils, weed control, disease and insect control, good seed bed preparation, proper seeding methods, and timely harvest.

Recommended soil sampling procedures should be followed in order to estimate fertilizer needs. The Oregon State University Extension Service agent in your county can provide you with soil sampling instructions, soil sample bags, and information sheets.

NITROGEN (N)

Liberal amounts of available N are required for optimum yields of perennial ryegrass seed.

On new seedings, place 20-40 lbs N/A 1 to 2 inches below the seed. At least 1 inch of soil should separate the seed and fertilizer.

On established stands, a total annual application of 120 to 140 lbs N/A is suggested.

Apply 20 to 30 lbs N/A in the fall. Apply 80 to 100 lbs N/A between March 15 and April 15.

Higher rates of fall applied N can be used where fields are grazed during the winter months.

Do not make spring applications of N until grazing has been completed.

The application of nitrate N to wet soils can result in the loss of N through reduction of nitrate.

PHOSPHORUS (P)

Soil testing should be used to evaluate the need for P fertilization.

On new seedings, when the OSU soil test for P is below 30 ppm, place 30 lbs P_2O_5/A near the seed. At least 1 inch of soil should separate the seed and fertilizer. The application rate should be increased by 50% when P is broadcast rather than placed near the seed

On established stands, *P should be broadcast in the fall.*

If the OSU soil test for P reads (ppm):	Apply this amount of phosphate (P_2O_5): lbs/A
0 to 15	40 - 60
15 to 25	30 - 40
Over 25	None

POTASSIUM (K)

Soil testing should be used to evalute the need for K fertilization.

On new seedings, when the OSU soil test for K is below 100 ppm, place 25 lbs K_2O/A near the seed. At least 1 inch of soil should separate the seed and fertilizer. The K application rate should be increased by 50% where K is broadcast.

On established stands, *K should be broadcast in the fall.*

If the OSU soil test for K reads (ppm):	Apply this amount of potash (K_2O): (lbs/A)
0 to 100	60
Over 100	None

SULFUR (S)

Include 10-15 lbs/A of S in the annual fertilizer program for perennial ryegrass. S is sometimes contained in fertilizers used to supply other nutrients such as N, P, and K, but may not be present in sufficient quantity.

Plants absorb S in the form of sulfate. Fertilizer materials supply S in the form of sulfate and elemental S.

Elemental S must convert to sulfate in the soil before the S becomes available to plants. The conversion of elemental S to sulfate is usually rapid for fine ground (less than 40 mesh) material in warm moist soil.

S in the sulfate form can be applied at planting time. Some S fertilizer materials such as elemental S and ammonium sulfate have an acidifying effect on soil.

The S requirements of perennial ryegrass can be provided by:

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1. The annual application of 10-15 lbs S/A in the form of sulfate or as fine ground (finer than 40 mesh) elemental S. Elemental S will not be available to plants until the soil warms up.
2. Applying 30-40 lbs S/A as sulfate or fine ground elemental S every second year.
3. Applying coarser ground elemental S at higher rates and less frequently.

OTHER NUTRIENTS

Responses of perennial ryegrass to nutrients other than those discussed in this guide have not been observed in Oregon.

LIME

Perennial Ryegrass has responded to applications of lime in experiments conducted on acid soils in the Willamette Valley.

The application of lime is suggested when the soil pH is below 5.5 or the soil test for calcium (Ca) is below 5.0 meq Ca/100g. Lime should be worked into the seedbed at least several weeks before seeding. The amount of lime required is based on an SMP lime requirement test.

If the OSU SMP buffer test for lime reads:	Apply this amount of lime (T/A):
Below 5.2	4 - 5
5.2 - 5.5	3 - 4
5.5 - 5.8	2 - 3
5.8 - 6.2	1 - 2
Over 6.2	0

The suggested liming rate is based on 100 score lime. Liming materials should be checked for score.

A lime application is effective over several years.

The use of N fertilizers for grass seed crops will tend to increase soil acidity (decrease soil pH). This should be considered in establishing or renovating perennial grass seed fields.

The surface application of lime to established seed fields could increase the soil pH in the surface one-half inch of soil and thereby increase the possibility of N loss from ammonium N and urea due to volatilization. Also, broadcasting lime on established stands of perennial grasses is not as effective as mixing lime with the soil.

Evaluate the soil acidity problem before making new plantings. The lime application should allow for some decrease in soil pH during the life of a perennial stand of grass.

Some soils may have a fairly high OSU SMP buffer value (over 6.2) and a low pH (below 5.3). This condition can be caused by the application of acidifying fertilizer. In this case the low pH value is temporary and the pH of the soil will increase as the fertilizer completes its reaction with the soil. This temporary "active" acidity from fertilizer is encountered following recent applications of most nitrogen fertilizer materials. Acidifying fertilizers also have a "long term" acidifying effect on soil which is cumulative and leads to lower OSU SMP buffer readings.

Sandy soils to which fertilizers have not been recently applied sometimes record low pH and high SMP buffer values. In such cases, a light application of lime (1 to 2 T/A) should suffice to neutralize soil acidity.

For acid soils low in Mg (less than 0.5 meq Mg/100g of soil) one ton/A of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

The P, K, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Thomas Doerge, Department of Soil Science; Hugh Gardner and T. L. Jackson, Extension Soil Scientists; and Harold Youngberg, Extension Agronomist; Extension Service and Agricultural Experiment Station, Oregon State University, Corvallis, Oregon.

COOPERATIVE EXTENSION SERVICE
OREGON STATE UNIVERSITY
Oregon Counties and the U.S. Department of Agriculture Cooperating

Oregon State University Fertilizer Guide for

FG 36
January 1970

TALL FESCUE

(Western Oregon--West of Cascades)

Nitrogen is the most important nutrient affecting the yield of this crop.

NITROGEN (N)

Fall application

Apply 50 to 60 lbs N/A in the fall to established stands.

Higher rates of fall applied N can be used where ryegrass fields are grazed during the winter months.

Spring application

Do not make spring applications of N until grazing has been completed.

The application of nitrate N to poorly drained soils where water is still standing can result in some volatilization loss of N.

Apply 90 to 100 lbs N/A in February or March.

PHOSPHORUS (P)

P, when applied to established stands, should be broadcast in the fall.

If the OSU soil test for P reads (ppm):	Apply this amount (lb/A) P_2O_5 x 0.44 =	P
0 to 15	40-60	18-26
15 to 30	30-40	13-18
over 30	none	

The P content of fertilizer is expressed as the oxide (P_2O_5) on fertilizer labels. Multiply P_2O_5 by 0.44 to convert to P.

POTASSIUM (K)

K, when applied to established stands, should be broadcast in the fall.

If the OSU soil test for K reads (ppm):	Apply this amount (lb/A) K_2O x 0.83 =	K
0 to 100	60	50
over 100	none	

The K content of fertilizer is expressed as the oxide (K_2O) on fertilizer labels. Multiply K_2O by 0.83 to convert to K.

ON NEW SEEDINGS

Banding low rates of fertilizer below the seed at planting has increased seedling vigor. With 12 to 20 inch row spacing:

1. Apply 20 to 40 lbs N/A banded at planting.
2. With OSU soil test for P below 45 ppm--Include 30 to 40 lbs P_2O_5/A in the band.
3. With OSU soil test for K below 150 ppm--Include 15 to 30 lbs K_2O/A in the band.

SULFUR (S)

A minimum of 7 to 15 lbs of S/A should be included in the fertilizer program each year.

Heavier applications of S every second year should be adequate.

MAGNESIUM, BORON, AND ZINC

To date, no response has been observed from applications of these nutrients to grass seed crops in the Willamette Valley.

LIME

When the pH of the soil is below 5.5 or the OSU soil test for calcium (Ca) is below 5.0 meq Ca/100g soil, apply lime and work into the seedbed before planting.

A lime application is effective over several years.

The use of N fertilizers for grass seed crops will tend to increase soil acidity (decrease soil pH). This should be considered in establishing or renovating perennial grass seed fields.

The surface application of lime to established seed fields could increase the soil pH in the surface one-half inch of soil and thereby increase the possibility of N loss from ammonium N and urea due to volatilization. Also, broadcasting lime on established stands of perennial grasses is not as effective as mixing lime with the soil.

Evaluate the soil acidity problem before making new plantings. The lime application should allow for some decrease in soil pH during the life of a perennial stand of grass.

The P, K, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Recommendations based on field demonstrations and observation of growers results.

Prepared by E. Hugh Gardner, Soils, and Rex Warren, Farm Crops, Cooperative Extension Service, Oregon State University, Corvallis, Oregon. Reviewed by a committee of Willamette Valley County Extension agents.

Appendix C

FG 45
Revised March 1982

Fertilizer Guide

ORCHARD GRASS SEED
(Western Oregon—West of Cascades)

Good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended varieties, selection of adapted soils, weed control, disease and insect control, good seed bed preparation, proper seeding methods, and timely harvest.

Recommended soil sampling procedures should be followed in order to estimate fertilizer needs. The Oregon State University Extension Service agent in your county can provide you with soil sampling instructions, soil sample bags, and information sheets.

NITROGEN (N)

Liberal amounts of available N are required for optimum yields of orchard grass seed.

On new seedings, place 20-40 lbs N/A near the seed. At least 1 inch of soil should separate the seed and fertilizer.

On established stands, a total annual application of 120 to 140 lbs N/A is suggested.

Apply 20 to 30 lbs N/A in the fall. Make one or two applications totalling 100 to 120 lbs N/A between March 1 and April 1.

Higher rates of fall applied N can be used where fields are grazed during the winter months.

Do not make spring applications of N until grazing has been completed.

The application of nitrate N to wet soils can result in the loss of N through reduction of nitrate.

PHOSPHORUS (P)

Soil testing should be used to evaluate the need for P fertilization.

On new seedings, when the OSU soil test for P is below 30 ppm, place 30 lbs P_2O_5/A near the seed. At least 1 inch of soil should separate the seed and fertilizer. The application rate should be increased by 50% when P is broadcast rather than placed near the seed.

On established stands, *P should be broadcast in the fall.*

If the OSU soil test for P reads (ppm):	Apply this amount of phosphorus (P_2O_5)-lbs/A
0 to 15	40 - 60
15 to 25	30 - 40
Over 25	None

POTASSIUM (K)

Soil testing should be used to evalute the need for K fertilization.

On new seedings, when the OSU soil test for K is below 100 ppm, place 25 lbs K_2O/A near the seed. At least 1 inch of soil should separate the seed and fertilizer. The K application rate should be increased by 50% where K is broadcast.

On established stands, *K should be broadcast in the fall.*

If the OSU soil test for K reads (ppm):	Apply this amount of potash (K_2O)-(lbs/A)
0 to 100	60
Over 100	None

SULFUR (S)

Include 10-15 lbs/A of S in the annual fertilizer program for orchard grass. S is sometimes contained in fertilizers used to supply other nutrients such as N, P, and K, but may not be present in sufficient quantity.

Plants absorb S in the form of sulfate. Fertilizer materials supply S in the form of sulfate and elemental S.

Elemental S must convert to sulfate in the soil before the S becomes available to plants. The conversion of elemental S to sulfate is usually rapid for fine ground (less than 40 mesh) material in warm moist soil.

S in the sulfate form can be applied at planting time. Some S fertilizer materials such as elemental S and ammonium sulfate have an acidifying effect on soil.

OREGON STATE UNIVERSITY EXTENSION SERVICE

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The S requirements of orchard grass can be provided by:

1. The annual application of 10-15 lbs S/A in the form of sulfate or as fine ground (finer than 40 mesh) elemental S. Elemental S will not be available to plants until the soil warms up.
2. Applying 30-40 lbs S/A as sulfate or fine ground elemental S every second year.
3. Applying coarser ground elemental S at higher rates and less frequently.

OTHER NUTRIENTS

Responses of orchard grass to nutrients other than those discussed in this guide have not been observed in Oregon.

LIME

Orchard grass has responded to applications of lime in experiments conducted on acid soils in the Willamette Valley.

The application of lime is suggested when the soil pH is below 5.8 or the soil test for calcium (Ca) is below 5.0 meq Ca/100g. Lime should be worked into the seedbed at least several weeks before seeding. The amount of lime required is based on an SMP lime requirement test.

If the OSU SMP buffer test for lime reads:	Apply this amount of lime (T/A):
Below 5.5	4 - 5
5.5 - 5.8	3 - 4
5.8 - 6.1	2 - 3
6.1 - 6.5	1 - 2
Over 6.5	0

The suggested liming rate is based on 100 score lime. Liming materials should be checked for score.

A lime application is effective over several years.

The use of N fertilizers for grass seed crops will tend to increase soil acidity (decrease soil pH). This should be considered in establishing or renovating perennial grass seed fields.

The surface application of lime to established seed fields could increase the soil pH in the surface one-half inch of soil and thereby increase the possibility of N loss from ammonium N and urea due to volatilization. Also, broadcasting lime on established stands of perennial grasses is not as effective as mixing lime with the soil.

Evaluate the soil acidity problem before making new plantings. The lime application should allow for some decrease in soil pH during the life of a perennial stand of grass.

Some soils may have a fairly high OSU SMP buffer value (over 6.2) and a low pH (below 5.3). This condition can be caused by the application of acidifying fertilizer. In this case the low pH value is temporary and the pH of the soil will increase as the fertilizer completes its reaction with the soil. This temporary "active" acidity from fertilizer is encountered following recent applications of most nitrogen fertilizer materials. Acidifying fertilizers also have a "long term" acidifying effect on soil which is cumulative and leads to lower OSU SMP buffer readings.

Sandy soils to which fertilizers have not been recently applied sometimes record low pH and high SMP buffer values. In such cases, a light application of lime (1 to 2 T/A) should suffice to neutralize soil acidity.

For acid soils low in Mg (less than 0.5 meq Mg/100g of soil) one ton/A of dolomite lime can be used as a Mg source. Dolomite and ground limestone have about the same ability to neutralize soil acidity.

The P, K, and lime recommendations are based on soil test values from the Soil Testing Laboratory, OSU, Corvallis, Oregon.

Prepared by Thomas Doerge, Department of Soil Science, Hugh Gardner and T. L. Jackson, Extension Soil Scientists, and Harold Youngberg, Extension Agronomist; Extension Service and Agricultural Experiment Station, Oregon State University, Corvallis, Oregon.

Appendix D

AgIII-XIII-49

OREGON STATE UNIVERSITY
EXTENSION
SERVICE

COLONIAL BENTGRASS SEED
Marion & Yamhill Counties

Based on:

1. 150 acres on a 600 acre farm
2. 350-lb. yield per acre
3. 10-year life of stand
4. Machine labor @ $6.00/hr.
5. Unskilled seasonal labor @ $4.50/hr.[1]
6. 130 hp tractor

PRODUCING YEAR

INPUTS PER ACRE

Item	Labor		Machinery	Other		Total cost
	Hrs.	Value ($)	($)	Item	Value ($)	($)
Cultural Operations[2]						
Herbicide (fall)				Chem. Custom	5.70 3.50	9.20
Fertilizer (spring)	.25	1.50	2.70	N	20.00	24.20
Herbicide				Chemical Custom	3.75 3.50	7.25
Spot spray weeds (3 men)	.5	2.50	1.70	Chem.	3.80	8.00
Harvest Operations						
Combine	.67	4.00	29.60			33.60
Hauling	.67	3.00	.70			3.70
Processing ($3.50/cwt. in)				Custom	14.00	14.00
Bags ($.75/cwt.)					2.60	2.60
Certification ($1.00 + .10/cwt.)					1.35	1.35
Seed tests ($.18/cwt.)					.65	.65
Highland Bentgrass Comm. ($.35/cwt.)					1.25	1.25
Post-Harvest Operations						
Prepare firebreaks[3]	.02	.10	.35			.45
Field burning (5 men)	.1	.50	.75	Fee	3.50	4.75
Other Costs						
Overhead labor	.44	2.65				2.65
Land charge [4]					87.00	87.00
Land charge on firebreaks					2.60	2.60
Operating capital interest (12%)					5.60	5.60
General overhead					8.45	8.45
Management charge					4.00	4.00
Amortized establishment cost (over)					34.10	34.10
Cash Costs		4.85	16.10		80.25	101.20
Non-Cash Costs		9.40	19.70		125.10	154.20
TOTAL COST		14.25	35.80		205.35	255.40
Cost per cwt. of seed						72.95

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[1] Includes payroll taxes and benefits.

[2] Check with your county agent for specific fertilizer and chemical recommendations.

[3] Rake and plow firebreaks comprising about 3% of acreage.

[4] Land-charge is based on rental value but is considered a non-cash cost.

Department of Agricultural and Resource Economics, December 1979.

COLONIAL BENTGRASS SEED
Marion & Yamhill Counties

ESTABLISHMENT YEAR — INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[1]						
Disc (4X) (fall)	1.00	6.00	8.50			14.50
Field cultivator(3X)	.67	4.00	7.55			11.55
Field cultivator (10X) (summer)	2.23	13.40	25.15			38.55
Harrow and roll (3X) (fall)	.5	3.00	5.70			8.70
Drill seed & fert. (fall)	.33	2.00	5.40	Seed	3.00	
				N-P	15.00	25.40
Other Costs						
Overhead labor	.7	4.20				4.20
Land charge 2/					87.00	87.00
Operating capital interest (12%)					2.75	2.75
General overhead					4.10	4.10
Management					4.00	4.00
Cash Costs		-	23.50		24.85	48.35
Non-Cash Costs		32.60	28.80		91.00	152.40
TOTAL COST		32.60	52.30		115.85	200.75
Amortized Establishment Cost (10 years @ 11%)						34.1

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[1] Check with your county agent for specific fertilizer and chemical recommendations.

[2] Land charge is based on rental value but is considered a non-cash cost.

These data were obtained and computed by Gale Gingrich and John Burt, County Extension Agents, and David Holst, Extension Economics Assistant, in cooperation with Marion and Yamhill County growers.

December 1979.

Appendix D

OREGON STATE UNIVERSITY
EXTENSION SERVICE

AgIII-XIII-51

FINE FESCUE
Non-summer fallow system
Clackamas & Marion Counties

Based on:

1. 350 acres on a 600 acre farm
2. 750-lb. yield
3. 5-year life of stand
4. Machine operator labor @ $7.00/hr.
5. Unskilled seasonal labor @ $5.25/hr.1/
6. 130 hp tractor

PRODUCING YEAR — INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations 2/						
Herbicide (fall)				Chem. Custom	12.00 4.50	16.50
Fertilizer (fall)	.25	1.75	6.70	N-P-S	27.50	35.95
Fertilizer (spring)	.25	1.75	6.70	N	25.00	33.45
Spot spray weeds (3 men)	1.0	5.85	4.10	Chem.	3.00	12.95
Herbicide				Chem. Custom	1.40 4.50	5.90
Harvest Operations						
Swath, 12'	.30	2.10	9.90			12.00
Combine	.50	3.50	37.10			40.60
Hauling	.50	2.65	1.00			3.65
Processing ($3.50/cwt. in)				Custom	31.25	31.25
Bags ($1.00/cwt.)					7.50	7.50
Certification ($1.10 + .12/cwt.)					2.00	2.00
Seed tests ($.20/cwt.)					1.50	1.50
Fine Fescue comm. ($.40/cwt.)					3.00	3.00
Post Harvest Operations						
Prepare firebreak 3/	.03	.15	.50			.65
Field burning (5 men)	.1	.55	1.50	Fee	3.50	5.55
Other Costs						
Overhead labor	.6	4.20				4.20
Land charge 4/					100.00	100.00
Land charge on firebreaks					3.00	3.00
Operating capital interest (14.5%)					12.95	12.95
General overhead					15.50	15.50
Management charge					5.00	5.00
Amortized establishment cost (over)					102.35	102.35
Cash Costs		6.70	29.55		155.10	191.35
Non-Cash Costs		15.80	37.95		210.35	264.10
TOTAL COST		22.50	67.50		365.45	455.45
Cost per cwt. of seed @ 600 lb. yield						74.45
Cost per cwt. of seed @ 750 lb. yield						60.75
Cost per cwt. of seed @ 900 lb. yield						51.60

1/ Includes payroll taxes and benefits.
2/ Check with your county agent for specific fertilizer and chemical recommendations.
3/ Rake and plow firebreaks comprising about 3% of acreage.
4/ Land charge is based on rental value but is considered a non-cash cost. The majority of rentals are crop share. In these cases, the land charge varies with price and yield variations.

ESTABLISHMENT YEAR	INPUTS PER ACRE					
	Labor			Other		Total cost
Item	Hrs.	Value ($)	Machinery ($)	Item	Value ($)	($)
Cultural Operations 1/						
Disc (2X) (fall) 2/	.50	3.50	15.40			18.90
Field cultivator (2X) (fall) 2/	.45	3.15	12.55			15.70
Prepare firebreak 3/	.03	.15	.50			.65
Field burning (5 men)	.1	.55	1.50	Fee	3.50	5.55
Herbicide (fall)				Chem.	33.35	
				Custom	4.50	37.85
Lime				Mtls. & App.	75.00	75.00
Herbicide (spring)				Chem.	25.00	
				Custom	4.50	29.50
Drill seed (mid-May)	.30	2.10	9.45	Seed	10.00	
				Fert.	15.50	37.05
Herbicide (summer)				Chem.	3.50	
				Custom	4.50	8.00
Other Costs						
Overhead labor	1.00	7.00				7.00
Land charge 4/					100.00	100.00
Operating capital interest (14.5%)					15.30	15.30
General overhead					9.00	9.00
Management charge					5.00	5.00
Cash Costs		.55	21.90		203.65	226.10
Non-Cash Costs		15.90	17.50		105.00	138.40
TOTAL COST		16.45	39.40		308.65	364.50
Amortized Establishment Cost (5 yrs @ 12.5%)						102.35

1/ Check with your county agent for specific fertilizer and chemical recommendations.

2/ These extra operations were performed before wheat was planted the previous year. So, the land will not require tillage after wheat harvest.

3/ Rake and plow firebreaks comprising about 3% of acreage.

4/ Land charge is based on rental value but is considered a non-cash cost. The majority of land rentals are crop share. In these cases, the land charge varies with price and yield variations.

These data were obtained and computed by Gale Gingrich and John Burt, County Extension Agents, and David Holst, Extension Economics Assistant, in cooperation with Clackamus and Marion County growers.

March 1981

Appendix D

AgIII-XIII-53

OREGON STATE UNIVERSITY
EXTENSION SERVICE

KENTUCKY BLUEGRASS
Willamette Valley

Based on:

1. 100 acres
2. 700-lb. yield
3. 8-year life stand
4. Machine operator labor @ $6.00/hr.[1]
5. Unskilled seasonal labor @ $4.50/hr.[1]

PRODUCING YEAR	INPUTS PER ACRE					
	Labor			Other		Total cost
Item	Hrs.	Value ($)	Machinery ($)	Item	Value ($)	($)
Cultural Operations[2]						
Herbicide (fall)				Chem.	11.40	
				Custom	3.50	14.90
Fertilizer (fall)	.25	1.50	3.25	N-P-K	21.50	26.25
Fertilizer (spring)	.25	1.50	3.25	N	41.00	45.75
Herbicide (spring)				Chem.	2.25	
				Custom	3.50	5.75
Insecticide & rust control (4X)				Chem.	33.00	
				Custom	14.00	47.00
Roguing (1X)	2.25	10.15		Chem.	2.00	12.15
Harvest Operations						
Swath, 12'	.20	1.20	4.50			5.70
Combine	.65	4.00	29.60			33.60
Hauling	.65	3.00	1.70			4.70
Processing ($5.40/cwt. in)				Custom	50.40	50.40
Bags ($.70/cwt.)					4.90	4.90
Certification ($1.00 + .10/cwt.)					1.70	1.70
Seed tests ($.15/cwt.)					1.05	1.05
Post-Harvest Operations						
Prepare firebreak[3]	.02	.10	.40			.50
Field burning (5 men)	.1	.50	.80	Fee	3.50	4.80
Other Costs						
Overhead labor	.45	2.70				2.70
Land charge[4]					80.00	80.00
Land charge on firebreaks					2.40	2.40
Operating capital interest (12%)					14.80	14.80
General overhead					20.30	20.30
Management charge					4.00	4.00
Amortized establishment cost (over)					63.75	63.75
Cash Costs		13.50	19.60		226.80	261.90
Non-Cash Costs		11.15	23.90		150.15	185.20
TOTAL COST		24.65	43.50		378.95	447.10
Cost per cwt. of seed						63.85

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[1] Includes payroll taxes and benefits.

[2] Check with your county agent for specific fertilizer and chemical recommendations.

[3] Rake and plow firebreaks comprising about 3% of acreage.

[4] Land charge is based on rental value but is considered a non-cash cost.

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AgIII-XIII-54

KENTUCKY BLUEGRASS
Willamette Valley

ESTABLISHMENT YEAR	INPUTS PER ACRE					
	Labor			Other		Total
Item	Hrs.	Value	Machinery	Item	Value	cost
		($)	($)		($)	($)
Cultural Operations[1]						
Disc (2X)	.50	2.50	4.26			6.76
Sub-soiler	.60	3.00	7.15			10.15
Plow, 5-16"	.35	1.75	4.73			6.48
Culti-mulch (2X)	.50	2.50	6.89			9.39
Harrow & roll (3X)	.5	2.50	4.08			6.58
Level (2X)	.50	2.50	9.75			12.25
Lime				Custom	44.00	44.00
Harrow & roll	.17	.85	1.39			2.24
Chem. seedbed & drill (2 men)	.67	2.85	2.10	Chem.	8.30	
				Carbon	11.00	
				Mach. rent	4.50	
				Seed	3.00	
				N-P-K	20.48	52.23
Irrigation (1X)	2.0	7.00	11.00	Electricity	2.30	20.30
Other Costs						
Overhead labor	.76	3.79				3.79
Interest on land ($900 @ 9%)					81.00	81.00
Taxes on land (FUV)					11.20	11.2
Operating capital interest (10%)					6.55	6.55
General overhead					12.30	12.30
Management charge					3.00	3.00
Cash Costs		8.17	17.12		123.63	148.92
Non-Cash Costs		21.07	34.23		84.00	139.30
TOTAL COST		29.24	51.35		207.63	288.22
Amortized Establishment Cost (8 years @ 10%)						54.03

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[1] Check with your county agent for specific fertilizer and chemical recommendations.

December, 1975.

Appendix D

AgIII-XIII-55

OREGON STATE UNIVERSITY
EXTENSION SERVICE

ANNUAL RYEGRASS
South-Willamette Valley

Based on:

1. 400 acres
2. 1400-lb. yield per acre
3. Till method of production
4. Machine operator labor @ $6.00/hr.[1/]
5. Unskilled seasonal labor @ $4.50/hr.[1/]

INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[2/]						
Plow, 7-18"	.20	1.20	7.85			9.05
Lime [3/]				Mtls.&App.	10.60	10.60
Field cultivate,harrow,roll,(3X)	.45	2.70	16.90			19.60
Level, 16'	.15	.90	8.10			9.00
Drill seed & fert., 16'	.25	1.50	6.50	Seed N-P	2.00 15.60	25.60
Fertilizer (spring)	.25	1.50	3.25	N	26.00	30.75
Harvest Operations						
Swath, 12'	.20	1.20	4.50			5.70
Combine	.30	1.80	26.40			28.20
Hauling	.30	1.35	3.00			4.35
Processing ($1.50/cwt. in.)				Custom	22.10	22.10
Bags ($.70/cwt.)					9.80	9.80
Seed tests ($.03/cwt.)					.40	.40
Ryegrass Seed Comm. ($.07/cwt.)					1.00	1.00
Post Harvest Operations						
Prepare firebreak [4/]	.02	.10	.40			.50
Field burning (5 men)	.10	.50	.80	Fee	3.50	4.80
Other Costs						
Overhead labor	.70	4.20				4.20
Land charge [5/]					50.00	50.00
Operating capital interest (12%)					8.45	8.45
General overhead					12.80	12.80
Management charge					4.00	4.00
Cash Costs		1.70	35.00		112.25	148.95
Non-Cash Costs		15.25	42.70		54.00	111.95
Credit for grazing (sheep)		-	-		(3.00)	(3.00)
TOTAL COST		16.95	77.70		163.25	257.90
Cost per cwt. of seed						18.40

[1/] Includes payroll taxes and benefits.

[2/] Check with your county agent for specific fertilizer and chemical recommendations.

[3/] Lime charge amortized over 7 years at 11%.

[4/] Rake and plow firebreaks comprising about 3% of acreage.

[5/] Land charge is based on rental value but is considered a non-cash cost.

Department of Agricultural and Resource Economics, December 1979.

ANNUAL RYEGRASS
South-Willamette Valley

Based on:

1. 500 acres
2. 1400-lb. yield
3. No-till method of production
4. Machine operator labor @ $6.00/hr.
5. Unskilled seasonal labor @ $4.50/hr.[1]

INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[2]						
Herbicide				Chem.	8.75	
				Custom	3.50	12.25
Drill seed & fert.	.35	2.10	7.50	Seed	2.00	
(10' grassland drill)				N-P	15.60	27.20
Fertilizer (spring)	.25	1.50	3.25	N	26.00	30.75
Harvest Operations						
Swath, 12'	.20	1.20	4.50			5.70
Combine	.30	1.80	26.40			28.20
Hauling	.30	1.35	3.00			4.35
Processing ($1.50/cwt. in.)				Custom	22.10	22.10
Bags ($.70/cwt.)					9.80	9.80
Seed tests ($.03/cwt.)					.40	.40
Ryegrass Seed Comm. ($.07/cwt.)					1.00	1.00
Post-Harvest Operations						
Prepare firebreak 3/	.02	.10	.40			.50
Field burning (5 men)	.1	.50	.80	Fee	3.50	4.80
Other Costs						
Overhead labor	.40	2.40				2.40
Land charge 4/					50.00	50.00
Operating capital interest (12%)					7.60	7.60
General overhead					11.50	11.50
Management charge					4.00	4.00
Cash Costs		1.70	20.65		111.75	134.10
Non-Cash Costs		9.25	25.20		54.00	88.45
Credit for grazing (sheep)		-	-		(3.00)	(3.00)
TOTAL COST		10.95	45.85		165.75	219.55
Cost per cwt. of seed						15.68

---

[1] Includes payroll taxes and benefits.

[2] Check with your county agent for specific fertilizer and chemical recommendations.

[3] Rake and plow firebreaks comprising about 3% of acreage.

[4] Land charge is based on rental value but is considered a non-cash cost.

Department of Agricultural & Resource Economics, December, 1979.

Appendix D

AgIII-XIII-57

OREGON STATE UNIVERSITY
EXTENSION SERVICE

PERENNIAL RYEGRASS - FORAGE TYPE
South-Willamette Valley

Based on:

1. 250 acres
2. 800-lb. yield
3. 4-year life of stand
4. Machine operator labor @ $6.00/hr.
5. Unskilled seasonal labor @ $4.50/hr.[1]

PRODUCING YEAR — INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[2]						
Fertilizer (fall)	.25	1.50	3.25	N-P	9.20	13.95
Fertilizer (spring)	.25	1.50	3.25	N	25.00	29.75
Herbicide				Chem.	4.30	
				Custom	3.50	7.80
Harvest Operations						
Swath, 12'	.20	1.20	4.50			5.70
Combine	.30	1.80	26.40			28.20
Hauling	.30	1.35	3.00			4.35
Processing ($1.75/cwt. in.)				Custom	18.65	18.65
Bags ($.70/cwt.)					5.60	5.60
Certification ($.70 + .08/cwt.)					1.35	1.35
Seed tests ($.03/cwt.)					.25	.25
Ryegrass Seed Comm. (.07/cwt.)					.55	.55
Post-Harvest Operations						
Prepare firebreak[3]	.02	.10	.40			.50
Field burning (5 men)	.1	.50	.80	Fee	3.50	4.80
Other Costs						
Overhead labor	.35	2.10				2.10
Land charge[4]					50.00	50.00
Land charge on firebreaks					1.50	1.50
Operating capital interest (12%)					6.10	6.10
General overhead					9.20	9.20
Management charge					4.00	4.00
Amortized establishment cost (over)					44.20	44.20
Cash Costs		1.70	18.70		87.20	107.60
Non-Cash Costs		8.35	22.90		99.70	130.95
Credit for grazing (sheep)		-	-		(1.50)	(1.50)
TOTAL COST		10.05	41.60		185.40	237.05
Cost per cwt. of seed						29.63

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[1] Includes payroll taxes and benefits.

[2] Check with your county agent for specific fertilizer and chemical recommendations.

[3] Rake and plow firebreaks comprising about 3% of acreage.

[4] Land charge is based on rental value but is considered a non-cash cost.

Department of Agricultural and Resource Economics, December, 1979.

AgIII-XIII-58

PERENNIAL RYEGRASS - FORAGE TYPE
South-Willamette Valley

FALL ESTABLISHMENT — INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total Cost ($)
Cultural Operations[1]						
Plow, 7-18"	.20	1.20	7.85			9.05
Lime				Mtls.&App.	37.50	37.50
Field cultivate,harrow,roll,16'(3X)	.45	2.70	16.90			19.60
Level, 16'	.15	.90	8.10			9.00
Herbicide				Chem. Custom	8.75 3.50	12.25
Drill seed	.25	1.50	6.50	Seed N-P-K	7.00 18.00	33.00
Other Costs						
Overhead labor	.40	2.40				2.40
Operating capital interest (12%)					3.05	3.05
General overhead					9.25	9.25
Management					2.00	2.00
Cash Costs		-	17.70		87.05	104.75
Non-Cash Costs		8.70	21.65		2.00	32.35
TOTAL COST		8.70	39.35		89.05	137.10
Amortized establishment cost (4 yrs. @ 11%)						44.20

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[1] Check with your county agent for specific fertilizer and chemical recommendations.

December 1979.

Appendix D

AgIII-XIII-59

OREGON STATE UNIVERSITY
EXTENSION SERVICE

TALL FESCUE
Willamette Valley

Based on:

1. 300 acres
2. 700-lb. yield
3. 8-year life of stand
4. Machine operator labor @ $6.00/hr.
5. Unskilled seasonal labor @ $4.50/hr.[1]

PRODUCING YEAR

INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[2]						
Fertilizer (fall)	.25	1.50	3.25	N-P	17.75	22.50
Herbicide (fall)				Chem.	6.50	
				Custom	3.50	10.00
Herbicide (spring)				Chem.	2.25	
				Custom	3.50	5.75
Fertilizer (spring)	.25	1.50	3.25	N	33.10	37.85
Harvest Operations						
Swath	.20	1.20	4.50			5.70
Combine	.50	3.00	28.15			31.15
Hauling	.50	2.25	2.70			4.95
Processing ($2.50/cwt. in.)				Custom	20.00	20.00
Bags ($.70/cwt.)					4.90	4.90
Certification ($1.00 + .12/cwt.)					1.85	1.85
Seed Tests ($.10/cwt.)					.70	.70
Post-Harvest Operations						
Prepare firebreak 3/	.02	.10	.40			.50
Field burning (5 men)	.1	.50	.80	Fee	3.50	4.80
Other Costs						
Overhead labor	.40	2.40				2.40
Land charge 4/					50.00	50.00
Land charge on firebreaks					1.50	1.50
Operating capital interest (12%)					7.90	7.90
General overhead					11.95	11.95
Management Charge					4.00	4.00
Amortized establishment cost (over)					40.25	40.25
Cash Costs		2.60	19.40		117.40	139.40
Non-Cash Costs		9.85	23.65		95.75	129.25
TOTAL COST		12.45	43.05		213.15	268.65
Cost per cwt. of seed						38.40

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[1] Includes payroll taxes and benefits

[2] Check with your county agent for specific fertilizer and chemical recommendations.

[3] Rake and plow firebreaks comprising about 3% of acreage.

[4] Land charge is based on rental value but is considered a non-cash cost.

Department of Agricultural and Resource Economics, December 1979.

AgIII-XIII-60

TALL FESCUE
Willamette Valley

ESTABLISHMENT YEAR	INPUTS PER ACRE					
	Labor			Other		Total cost
Item	Hrs.	Value ($)	Machinery ($)	Item	Value ($)	($)
Cultural Operations[1]						
Plow, 7-18"	.20	1.20	7.85			9.05
Lime				Custom	50.00	50.00
Disc, harrow, roll (2X)	.50	3.00	8.05			11.05
Level, (2X)	.30	1.80	16.20			18.00
Harrow and roll	.15	1.00	1.90			2.90
Drill seed (spring)	.25	1.50	6.50	Seed	6.50	14.50
Fertilizer	.25	1.50	3.25	N-P	17.75	22.50
Herbicide				Chem. Custom	2.25 3.50	5.75
Other Costs						
Overhead labor	.45	2.70				2.70
Land charge [2]					50.00	50.00
Operating capital interest (12%)					6.60	6.60
General overhead					10.00	10.00
Management charge					4.00	4.00
Cash Cost		-	19.70		96.60	116.3
Non-Cash Cost		12.70	24.05		54.00	90.75
TOTAL COST		12.70	43.75		150.60	207.05
Amortized establishment cost (8 yrs. @ 11%)						40.25

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[1] Check with your county agent for specific fertilizer and chemical recommendations.

[2] Land charge is based on rental value but is considered a non-cash cost.

December 1979.

OREGON STATE UNIVERSITY
EXTENSION SERVICE

Appendix D AgIII-XIII-61

ORCHARDGRASS SEED
Benton, Polk, & Lane Counties

Based on:

1. 300 acres
2. 800-lb. yield
3. 8-year life of stand
4. Machine operator labor @ \$6.00/hr.
5. Unskilled seasonal labor @ \$4.50/hr.[1]

PRODUCING YEAR INPUTS PER ACRE

Item	Labor Hrs.	Labor Value ($)	Machinery ($)	Other Item	Other Value ($)	Total cost ($)
Cultural Operations[2]						
Herbicide (fall)				Chem.	8.00	
				Custom	3.50	11.50
Spot spray weeds (3 men)	.30	1.50	1.05	Chem.	.50	3.05
Fertilizer (2X) spring	.50	3.00	6.50	N-P-K	47.25	56.75
Herbicide (spring)				Chem.	3.25	
				Custom	3.50	6.75
Harvest Operations						
Swath, 12'	.20	1.20	4.50			5.70
Combine	.50	3.00	28.15			31.15
Hauling	.50	2.25	2.90			5.15
Processing (\$3.50/cwt. in.)				Custom	31.50	31.50
Bags (\$1.10/cwt.)					8.80	8.80
Certification (\$1.00 + .12/cwt.)					1.95	1.95
Seed tests (\$.16/cwt.)					1.30	1.30
Orchardgrass Seed Comm. (\$.32/cwt.)					2.55	2.55
Post-Harvest Operations						
Prepare firebreaks [3]	.02	.10	.40			.50
Field burning (4 men)	.1	.50	.80	Fee	3.50	4.80
Other Costs						
Overhead labor	.60	3.60				3.60
Land charge [4]					50.00	50.00
Land charge on firebreaks					1.50	1.50
Operating capital interest (12%)					9.10	9.10
General overhead					13.80	13.80
Management charge					4.00	4.00
Amortized establishment cost (over)					40.40	40.40
Cash Costs		2.60	19.95		138.50	161.05
Non-Cash Costs		12.55	24.35		95.90	132.80
TOTAL COST [5]		15.15	44.30		234.40	293.85
Cost per cwt. of seed						36.75

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[1] Includes payroll taxes and benefits.

[2] Check with your county agent for specific fertilizer and chemical recommendations.

[3] Rake and plow firebreaks comprising about 3% of acreage.

[4] Land charge is based on rental value but is considered a non-cash cost.

[5] Total costs per acre may be higher if billbug control is required.

Department of Agricultural and Resource Economics, December 1979.

AgIII-XIII-62

ORCHARDGRASS SEED
Benton, Polk, & Lane Counties

ESTABLISHMENT YEAR — INPUTS PER ACRE

Item	Labor		Machinery	Other		Total cost
	Hrs.	Value ($)	($)	Item	Value ($)	($)
Cultural Operations[1]						
Plow, 5-16"	.35	2.10	6.75			8.85
Lime				Custom	56.00	56.00
Disc, harrow, roll, 12' (4X)	1.00	6.00	16.10			22.10
Level, 12'	.25	1.50	7.80			9.30
Drill seed & fert., 12'	.30	1.80	6.25	Seed	3.00	
				N-P-K	8.55	19.60
Weed control[2]				Chem.	15.00	
				Custom	3.50	18.50
Other Costs						
Overhead labor	.45	2.70				2.70
Land charge [3]					50.00	50.00
Operating capital interest (12%)					6.75	6.75
General overhead					10.25	10.25
Management Charge					4.00	4.00
Cash Costs		-	16.60		103.05	119.65
Non-Cash Costs		14.10	20.30		54.00	88.40
TOTAL COST		14.10	36.90		157.05	208.05
Amortized establishment cost (8 years @ 11%)						40.40

---

[1] Check with your county agent for specific fertilizer and chemical recommendations.

[2] A number of alternative weed control practices are used ranging in costs from $5 to $50 per acre.

[3] Land charge is based on rental value but is considered a non-cash cost.

December 1979.

Appendix E

The Oregon Seed Certification Program

The Oregon seed certification program serves a vital role in making improved varieties of forage, turf, and food crops available to agricultural producers. Through the certification process, the limited quantity of improved seed and propagating material released by plant breeders as new varieties are increased to quantities adequate to meet the needs of the agricultural industry. The new varieties have the superior characteristics of improved disease resistance, yield, or quality needed by commercial growers. The certification staff monitors the seed multiplication process and verifies that the production has met the criteria necessary to protect the genetic identity of these new varieties.

The Oregon seed certification program has grown from the certification of a few acres of potatoes in 1916 and cereal grains in 1918, to one that now includes thousands of acres of grasses, legumes, cereals, potatoes, mint, and forest trees. It is one of the largest state certification programs in the United States. The added value of certified seed increases the return to Oregon seed growers by an estimated $7.32 million annually.

This report summarizes the development and current status of the Oregon seed certification program. It provides a review of certification in Oregon, its organization, county involvement, and production trends. A data summary by crop appears in the Appendix.

EC 1090 **October 1981**

OREGON STATE UNIVERSITY EXTENSION SERVICE

Extension Service, Oregon State University, Corvallis, Henry A. Wadsworth, director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties. Extension invites participation in its activities and offers them equally to all people.

Organization and history

In Oregon, the certification responsibility is authorized by Oregon revised statutes 633.620 and 633.630 and is administered by the Dean of the School of Agriculture at Oregon State University. The certification program is a project of the Extension Service within the School of Agriculture's Crop Science Department, with a certification specialist as its leader. A certification board chaired by the Dean of Agriculture develops and adopts regulations and standards based on recommendations from commodity advisory groups (see Appendix, Figure 1). The board has representatives from OSU, seed growers, and the seed trade, and the board and advisory groups operate under specific bylaws. The Federal Seed Act also provides guidelines for the certification program.

Oregon did not enter the seed certification program as early as some states did, but since its organization the Oregon program has become widely recognized for its quality and size.

The initiative to begin a certification program was taken at the Oregon Agricultural College in about 1916. Professors George R. Hyslop and E. R. Jackman were chiefly responsible for organizing and guiding the Oregon certification program in the early years, and the present status and high standards were developed through their untiring efforts to build seed-quality consciousness among Oregon farmers. The actual certification of seeds began with wheat in 1918 in Umatilla, Union, and Wallowa Counties. Legume seed certification began in 1924 with Grimm alfalfa in Josephine County, and red clover was added in 1929. Grass seed certification started in 1926 with Astoria bentgrass in Clatsop County and Seaside bentgrass in 1927 in Coos County. Perennial ryegrass was included in 1932, with Highland bentgrass added in 1934.

The first crop varieties to be certified were ecotypes, or varieties developed in Oregon. The major market for these seeds was within the state, with markets expanding into other regions of the U.S. as the seed industry developed. A major shift in production in Oregon and the role of certification occurred with the release of new varieties from breeding programs in other states. Merion bluegrass is an example. This improved variety was released by Pennsylvania State University, but the first commercial seed production was in southern Oregon in the mid 1940s. The western U.S. had an advantage over traditional bluegrass-seed-growing areas in the Midwest, in that the western states were relatively free of common bluegrass contamination, and the environment favored high seed yields with excellent germination. Consequently, the system evolved whereby breeder seed was sent to Oregon for increase under the certification program, with certified seed returned to the eastern U.S. for turf use.

This system of specialized clean seed production has proven to be very successful and has been the model for seed increase of other turf and forage varieties released in the U.S. Today, many European-developed varieties are also sent to Oregon for increase, with certified seed returned to supply European markets. In this way, the Oregon certification program has contributed significantly to the growth of Oregon's annual $100 million seed industry.

In 1963, the U.S. became a participant in an international certification program sponsored by the Organization for Economic Cooperation and Development (OECD). The objective of the program is to increase worldwide trade and movement of improved varieties through an internationally recognized certification program. The Oregon Seed Certification Service is the designated authority to conduct the OECD program in Oregon. The OECD program has become a significant part of Oregon seed certification and has greatly aided the Oregon seed industry by facilitating international movement of seed. As a rule, only seed destined for export and included on the OECD variety list is certified under this program.

The Oregon Seed Certification Service, the Oregon State Seed Laboratory, and the Oregon Foundation Seed and Plant Materials Project comprise the Seed and Plant Services at OSU. The OSU Seed Laboratory is the official laboratory for testing Oregon certified seed. The laboratory has a highly skilled staff and performs many special tests important to certification and proper seed labeling. Seed samples collected under the direction of Extension agents are examined in the laboratory. Reports are reviewed by the certification staff and eligibility checked against field records. Seed lots meeting quality standards are approved and county offices notified. Tags are then attached under the supervision of county Extension staff.

The Oregon Foundation Seed and Plant Materials Project provides an important service to seed growers. The project maintains an inventory of foundation-class seed of Oregon public varieties for certified growers. The largest volume of foundation seed is of cereal varieties. The project also assists growers in obtaining foundation seed supplies of public varieties from other states.

The county Extension agents perform a vital function in the seed certification program, as they are the certification representatives within each county. The application forms and requests for certification are filed through the county Extension office where the crop is grown. The Extension agents supervise the sampling of the clean seed and the tagging and sealing of the bags of the certified product. During the 1979-80 fiscal year, crops were certified in 26 of Oregon's 36 counties. The certification acreages in Linn and Marion counties are the largest in the state. In 1979-80, fees from these two counties accounted for 38 percent of the total state acreage fees.

The seed certification program forms an integral part of the Extension educational program in agriculture. The certification staff works closely with the Crop Science Department at OSU as well as with county Extension personnel, and many varieties developed at OSU are included in the program.

The Oregon Seed Certification Service is a self-supporting program funded by fees paid by participants. Fees are levied on acres entered in the program and on pounds of seed certified. The fee structure is reviewed annually and adjusted as needed to meet the costs of the respective segments of the program.

Objectives

The Oregon Seed Certification Service is available to the public on a voluntary basis. The purpose of the program is to provide a system for the maintenance and increase of quality seed and propagating material. Each new variety entered in the program has special characteristics of disease resistance, greater productivity, environmental adaptation, or other features that give it unique value. It is essential that these specific characteristics be preserved during the process of multiplication if the variety is to provide maximum benefit to agriculture and the public.

The seed multiplication process under the certification program involves the supervision of the three or four generations of seed increase from the plant breeder to the commercial grower. Figure 1 shows the terminology used to refer to these generations of seed increase. The terminology differs slightly between the U.S. and the OECD systems of classification, both of which are used in the Oregon seed certification program.

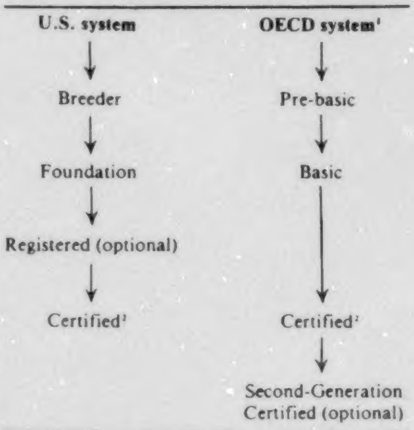


Figure 1. Generation systems used in Oregon seed certification program

¹ Organization for Economic Cooperation and Development (OECD) certification system.

² Certified class is used for commercial production and not for further increase (except for unusual circumstances).

Under the U.S. system of certification, four classes of seed increase are designated, with the registered class optional. Breeder-class seed is produced by the originator and provides the stock seed for the first increase. Production from this planting is designated "foundation class." Fields established with foundation-class material produce registered (with certain specific varieties) or certified seed. The certified class is the final generation in the program and is not intended for further seed increase but rather for commercial use—such as pasture, lawns, or grain production. The OECD system is similar to the U.S. system, but different terms are used to designate the generations of increase.

The certification and seed production system in Oregon is well established and can respond quickly to the needs for new varieties of food, forage, turf, and conservation uses. For example, one pound of perennial ryegrass breeder seed could be increased to more than one-half million pounds of certified seed in 5 years under the breeder-foundation-certified system. This is enough seed to plant 36,000 acres of pastur of an improved grass variety, with additional amounts of certified seed of that variety available each year.

Economic benefits

Certified grass and legume seed crops represent a major economic benefit to the state because of the large percentage that is exported, bringing nearly $100 million annually into the Oregon economy. Certified cereal crops, on the other hand, are marketed largely within the state and provide another type of economic benefit. Cereal production in Oregon is a $345 million industry, and the superior disease resistance and higher yields of these new varieties contribute significantly to the success of that industry. During 1970-79, an average of 6,739 acres of cereals were certified annually. This represents approximately 5 percent of the Oregon certification program, and the acreage of cereals certified increases with each release of a new variety from the Oregon Agricultural Experiment Station.

Crops certified under the OECD certification system totaled 27,456 acres in 1979, or 20 percent of the total acres certified in Oregon. The OECD program continues to grow at a higher rate than the overall certification program. The 1979 total OECD acreage increased by 8,000 acres, or a 42 percent increase over the 1978 total of 19,234 acres.

The adoption of the plant variety protection law by Congress in 1970 provided a significant stimulus to plant breeding activities by private firms. Many proprietary varieties—particularly grasses—have been released from these sources. Proprietary varieties are those developed by private firms who retain exclusive rights to produce and market the variety. Production figures on individual proprietary varieties are not released, but the growth in certification of these varieties reflects the importance that these firms attach to maintaining the genetic identity of varieties through the certification program. In 1979, the proprietary and OECD varieties represented more than 50 percent of the grass acreage certified in Oregon (see Figure 2).

The acreage certified under the Oregon program has increased steadily since its beginning, reaching a peak of 141,157 total acres in 1973. The 10-year trend of acres certified in the state from 1970-79 is shown in Figure 3; acreage figures by crop for the 1970-79 production years in the Oregon certification program are shown in the Appendix, Table 1-5.

Table 1 shows the number of acres certified by crop for 1979. Grass seed crops represented the largest group, with 100,122 acres or 74 percent of the total acreage. Legume crops certified represented 15 percent of the program, and cereals, 8 percent (see Figure 4).

The enhancement of international exchange of seed through the OECD system has provided Oregon seed growers with many new opportunities and aided the state economy in general. During the 1979 production year, 22.65 million pounds of seed varieties of foreign origin and 5.83 million pounds of domestic varieties were certified under the OECD standards by all states in the U.S. Of this total, Oregon's production was 17.55 million pounds of foreign varieties and 4.01 million pounds of domestic varieties. Thus, Oregon produced 73 percent of all crops certified under the OECD program in the U.S.

In 1979, 1,322 individual lots of seed were tagged for foreign shipment by Oregon certification staff. There were 431,314 individual OECD tags attached to verify genetic identity, representing 85 foreign and 14 domestic varieties.

The OECD program is continuing to expand. In 19[illegible] 328 new OECD lots were received in Oregon for further increase by Oregon seed companies and seed growers. Thus, the OECD program is becoming a very important factor in Oregon seed production, contributing an increasing percentage of certified acreage and also providing seed growers with a wide diversity of varieties from which to select.

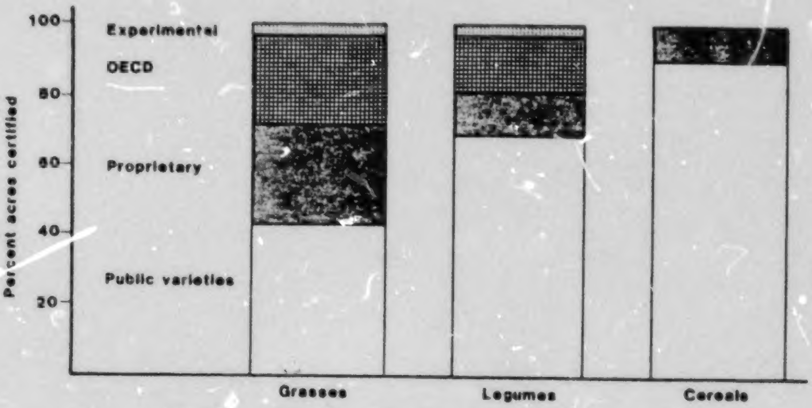


Figure 2. Sources of various crops certified in Oregon, 197

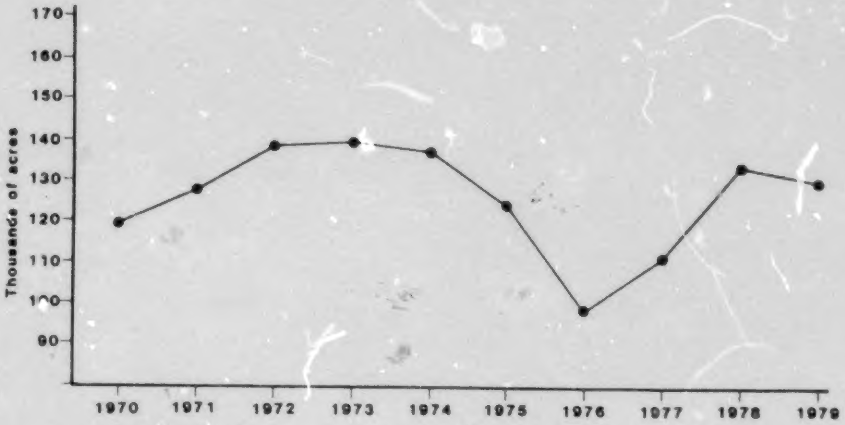


Figure 3. Acres approved for certification in Oregon all crops, 1970-79

Table 1

Number of Acres Certified in Oregon by Crop, 1979

Type	Grasses	Cereals	Legumes	Potatoes	Mint	Misc.
Public	46,669	10,118	14,643	2,954.40	477.865	98
Proprietary	28,604	682	2,139	0	0	0
OCED	24,153	0	3,461	0	0	43
Experimental	696	2	314	0	0	25
Total acres	100,122	10,802	20,557	2,954.40	477.865	166
Percent of total	74.12	8.00	15.22	2.19	.35	.12

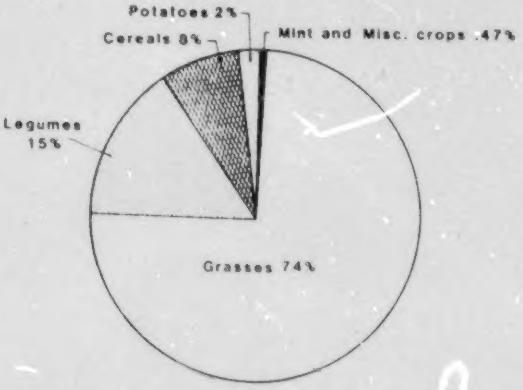


Figure 4. Oregon seed certification program by acres certified, 1979

Comparison: Oregon certified/total Oregon seed production

Oregon seed growers recognize the importance of quality in marketing seed, and preserving the genetic identity of a variety is an important quality factor. For this reason, Oregon seed producers grow a high percentage of their crop under the certification program.

Red and chewings fescue growers produced 81 percent of their crops under certification in 1979, with alfalfa, tall fescue, and orchardgrass above 65 percent. More than 50 percent of 1979's perennial ryegrass and bentgrass crops were approved for certification. Eleven major crop varieties grown for seed in Oregon are listed in Table 2; these crops represent 328,000 acres grown for seed in 1979, with 116,020 acres or 35 percent of the total acreage approved for certification. (See also Figure 5).

Comparison: total U.S. certified/ Oregon certified seed production

Oregon is extremely well known for its quality seed production and is the major producer of certified cool-season grass varieties in the U.S. Two hundred twenty-seven varieties of 14 grass and legume seed crops were grown under the Oregon certification program in 1979. Nearly 100 percent of the red fescue, orchardgrass, ryegrass, and bentgrass certified in the U.S. is produced under the Oregon seed certification program, and more than 80 percent of the OECD and proprietary bluegrass and tall fescue seed (see Table 3 and Figure 6; see also Appendix, Table 6).

Table 2
Oregon Seed Crops, 1979

Crop	Total production (acres)	Certified production (acres)	Oregon acreage certified (percent)
Annual ryegrass	127,000	7,272	6
Perennial ryegrass	60,000	36,119	60
Bentgrass	18,000	9,189	51
Kentucky bluegrass	22,000	9,823	45
Tall fescue	10,000	7,678	77
Red & chewings fescue	22,000	17,916	81
Orchardgrass	16,000	10,979	69
Red clover	29,000	5,913	20
Alfalfa	14,000	11,018	79
Crimson clover	10,000	113	1
Total	328,000	116,020	35

Source: Oregon State University Extension Service, Statistical Reporting Service, USDA, and Oregon certification figures.

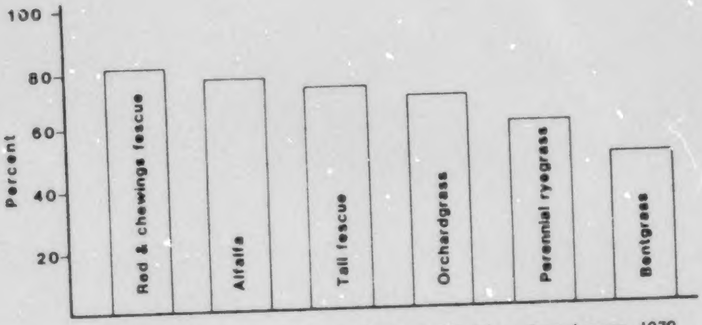


Figure 5. Percent of Oregon seed acreage certified for selected crops, 1979
Source: USDA and Oregon certification figures

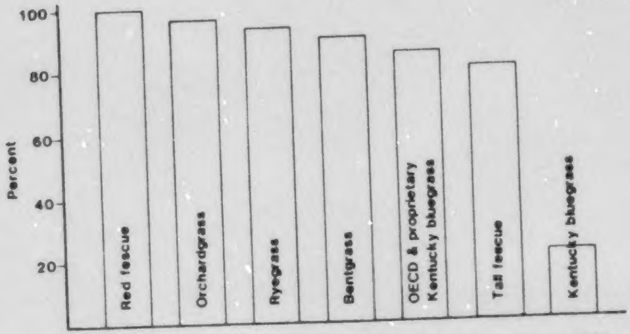


Figure 6. Percent of U.S. certified seed produced in Oregon, 1979
Source: 1979 AOSCA report (acres applied for certification)

Table 3
Oregon Certified Production as a Percent of U.S. Certified, 1979

Crop	Oregon certified (acres)	U.S. certified (acres)	Oregon/U.S. (percent)
Tall fescue	7,678	9,355	82
Orchardgrass	10,979	11,029	99
Ryegrass	43,381	44,193	98
Bentgrass	9,189	9,389	98
Kentucky bluegrass	9,823	43,609	23
OECD & proprietary Kentucky bluegrass	6,790	7,779	87
Red fescue	15,903	15,919	100

Source: 1979 AOSCA report (acres applied for certification).

Summary

Assurance of varietal identity and genetic purity adds to the value of a seed lot. Consequently, certified seed normally sells at a premium over uncertified seed and results in added income to seed growers. In 1979, the Oregon seed certification program added $7.32 million to the Oregon seed crop's value through premium prices paid for certified seed. To gain this added income, growers produced the seed under the required standards, which often include extra labor or other expenses. In 1979, for example, growers paid $332,000 in certification fees, or $1 in fees for every $22 of added return.

An even greater benefit accrues to world agriculture as a result of the seed certification program, in that improved varieties of crops are made available quickly in the form of certified seed. The financial returns due to crop improvement and increased production are measured in the billions of dollars. Rapid dissemination of the benefits of plant breeding will become more important in the future as population growth places greater pressure on limited agricultural resources.

The Oregon seed certification program approves from 130 to 140 thousand acres annually for 1,200 growers, each with an average of 3 to 4 certified seed fields. Certification is available for 325 specific varieties of 50 different seed crops—including potatoes, grass and legume seed, cereal grains, mint, vegetable crops, forest tree seed collection and forest seedlings, and several miscellaneous seed crops.

Oregon is and will remain a leading producer of high-quality seed. The combination of a desirable climate, experienced growers, excellent conditioning facilities, and extensive research make it possible for Oregon to market seed of the highest quality. The Oregon seed certification program plays an important role by assuring the purity and genetic identity of certified seed crops.

This circular was prepared by Ron Cook, seed certification assistant, and Harold Youngberg, Extension agronomist, Oregon State University.

Appendix

Appendix Table 1. Total Acres Certified in Oregon Certification Program, 1970-79

Crop	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	Avg.
Cereals	10,794	14,125	14,037	8,392	4,546	3,216	2,455	5,412	2,264	2,153	6,739
Grass	74,849	81,851	70,023	70,756	93,895	107,242	108,144	102,436	94,232	90,204	89,363
Experimental	1,042	1,193	---	---	---	---	---	---	---	---	224
Alfalfa, clover, and misc.	17,506	18,909	14,708	10,829	11,196	12,485	13,116	14,811	17,440	16,655	14,765
Potatoes	2,954	3,308	3,059	3,239	2,962	3,052	3,006	2,515	3,486	3,671	3,125
Mint	478	800	409	61	35	113	363	147	128	181	272
Turfgrass	0	0	50	15	0	0	0	0	0	0	7
OECD crops	27,456	19,234	14,250	9,547	11,458	11,804	14,073	12,632	9,623	7,227	13,730
Total	135,079	139,420	116,536	102,839	124,092	137,912	141,157	137,953	127,173	120,091	128,225

Appendix Table 2. Total Grass Crop Acres Certified, Oregon Certification Program, 1970-79

Year	Misc.	Bent-grass	Bluegrass	Fine fescue	Hard fescue	Tall fescue	Orchard-grass	Ryegrass	Proprietary varieties	Total
1979	---	6,711	3,055	5,552	40	6,773	8,678	15,645	28,395	74,849
1978	---	9,849	2,620	6,835	40	6,460	7,230	20,094	28,724	81,852
1977	---	8,983	3,014	7,013	85	5,899	7,042	18,496	19,491	70,023
1976	---	9,240	2,713	7,656	40	5,942	6,388	22,884	15,893	70,756
1975	---	14,204	5,162	9,952	40	8,291	7,695	40,217	8,334	93,895
1974	---	18,983	8,541	10,390	18	10,065	10,316	40,797	8,133	107,241
1973	22	19,558	10,469	8,946	18	12,018	11,837	37,755	7,522	108,143
1972	118	21,623	11,152	8,550	8	11,689	10,351	31,404	7,541	102,435
1971	224	21,098	10,046	7,725	8	11,852	8,525	29,157	5,599	94,232
1970	148	18,088	9,341	6,842	8	10,790	7,472	32,924	4,591	90,203

Appendix Table 3. Total Cereal Acres Certified, Oregon Certification Program, 1970-79

Year	Barley	Oats	Wheat	Proprietary varieties	Total
1979	996	587	9,176	36	10,795
1978	845	757	12,523	0	14,125
1977	869	1,069	11,836	265	14,039
1976	443	716	5,511	1,722	8,392
1975	184	411	2,408	1,543	4,546
1974	458	24	2,634	100	3,216
1973	659	115	1,224	458	2,456
1972	289	77	4,481	564	5,411
1971	465	151	1,648	—	2,264
1970	492	188	1,474	---	2,154

Appendix Table 4. Total Miscellaneous Acres Certified, Oregon Certification Program, 1970-79

Year	Mint	Experimental	Turfgrass	Potatoes	OECD Crops
1979	477.865	1,042.09	0	2,954.40	27,456.00
1978	800.416	1,193.00	0	3,307.55	19,233.90
1977	408.90	---	50	3,059.27	14,250.00
1976	60.90	—	15	3,239.35	9,547.00
1975	35.35	---	0	2,962.07	11,458.00
1974	112.80	—	0	3,052.10	11,803.50
1973	363.40	---	0	3,006.07	14,073.10
1972	146.75	---	0	2,514.50	12,632.00
1971	127.95	—	0	3,485.50	9,622.50
1970	181.39	---	0	3,671.00	7,226.50

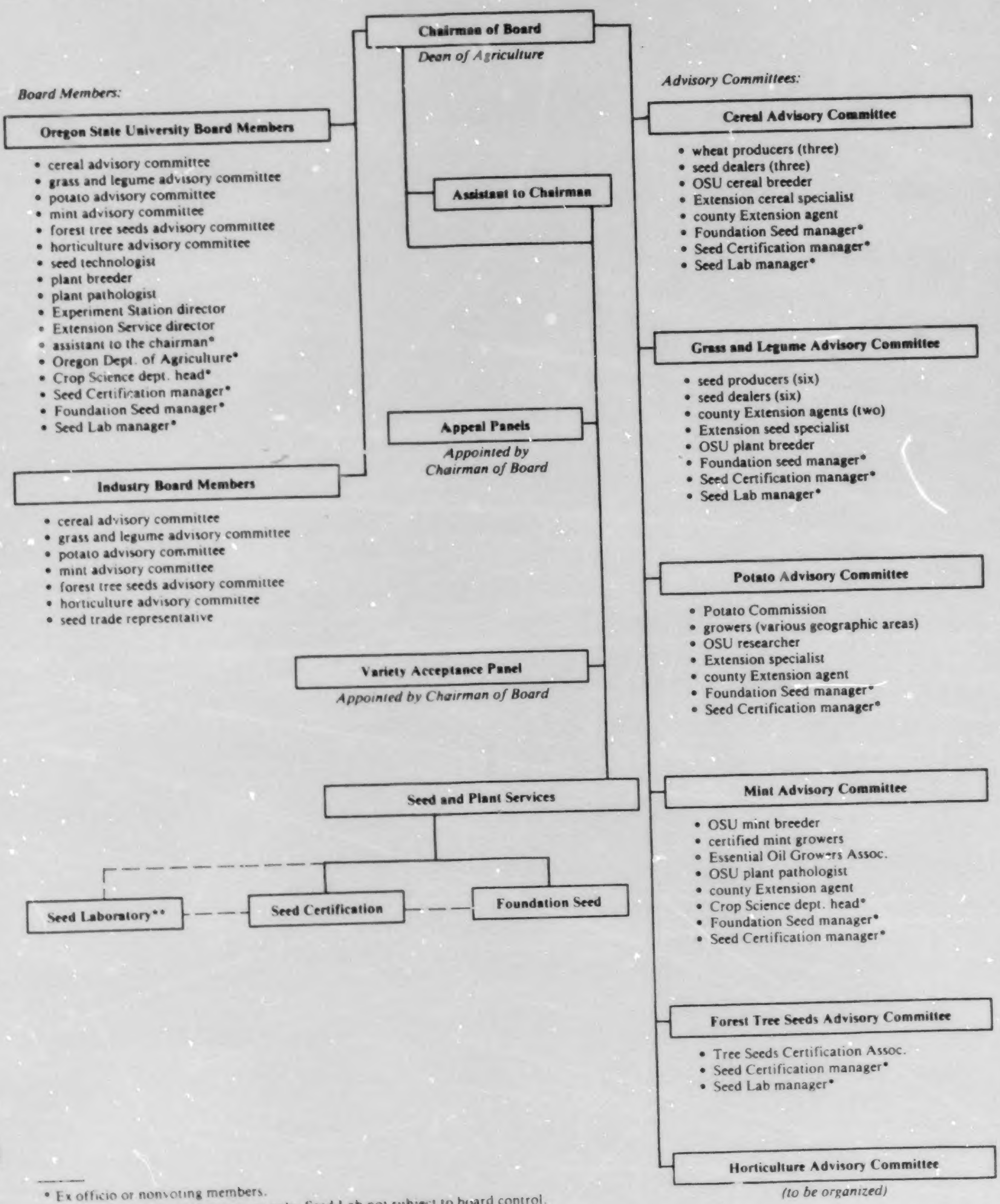
Appendix Table 5. Total Legume Acres Certified, Oregon Certification Program, 1970-79

Year	Birdsfoot trefoil	Meadow-foam & vetch	Beans	Proprietary legumes	Clover	Alfalfa	Total
1979	18	---	307	12,834	4,347	See Prop.	17,506
1978	15	—	324	11,536	7,034	See Prop.	18,909
1977	0	5	127	966	5,711	7,900	14,709
1976	54	12	126	465	3,162	7,010	10,829
1975	42	—	—	294	2,241	8,619	11,196
1974	71	---	---	432	2,301	9,681	12,485
1973	117	---	---	196	3,351	9,452	13,116
1972	114	40	—	79	5,655	8,923	14,811
1971	5	99	---	197	8,239	8,900	17,440
1970	18	139	—	647	7,153	8,698	16,655

Appendix Table 6. Seed Eligible for Certification (Thousands of Pounds)

Crop	1979	1978	1977	1976	1975	Avg.
Grasses						
Bentgrass	2,152	2,803	3,530	2,663	5,725	3,375
Bluegrass	1,303	1,411	1,722	1,009	1,979	1,485
Fine fescue	4,287	3,319	4,504	5,302	5,188	4,520
Hard fescue	—	16	5	---	---	4
Tall fescue	5,724	6,367	4,745	5,023	5,058	5,383
Orchardgrass	6,476	5,923	4 062	3,815	3,887	4,833
Ryegrass	9,506	15,820	14,578	12,884	20,483	14,654
Propietary grass varieties	20,498	18,611	15,709	10,375	12,418	15,522
Total	49,946	54,270	48,855	41,071	54,738	49,776
Legumes						
Alfalfa	---	---	---	2,923	4,153	1,415
Clover	966	1,127	1,065	519	478	831
Propietary legume varieties	3,361	3,844	3,450	75	83	2,163
Total	4,327	4,971	4,515	3,517	4,714	4,409
Cereals						
Barley	1,192	1,652	1,306	584	555	1,058
Oats	746	985	1,787	492	216	845
Wheat	21,131	20,918	17,568	12,949	6,551	15,823
Propietary cereal varieties	---	---	---	1,730	3,785	1,103
Total	23,069	23,555	20,661	15,755	11,107	18,829
OECD varieties	15,134	16,854	18,546	11,637	6,874	13,809
Grand total	92,476	99,650	92,577	71,980	77,433	86,823

Appendix Figure 1. Certification and Foundation Seed and Plant Material Board


Chairman of Board
Dean of Agriculture
Board Members:
Oregon State University Board Members
Industry Board Members
Assistant to Chairman
Appeal Panels
Appointed by Chairman of Board
Variety Acceptance Panel
Appointed by Chairman of Board
Seed and Plant Services
Seed Laboratory**
Seed Certification
Foundation Seed
Advisory Committees:
Cereal Advisory Committee
Grass and Legume Advisory Committee
Potato Advisory Committee
Mint Advisory Committee
Forest Tree Seeds Advisory Committee
Horticulture Advisory Committee
(to be organized)

Oregon State University Board Members

- cereal advisory committee
- grass and legume advisory committee
- potato advisory committee
- mint advisory committee
- forest tree seeds advisory committee
- horticulture advisory committee
- seed technologist
- plant breeder
- plant pathologist
- Experiment Station director
- Extension Service director
- assistant to the chairman*
- Oregon Dept. of Agriculture*
- Crop Science dept. head*
- Seed Certification manager*
- Foundation Seed manager*
- Seed Lab manager*

Industry Board Members

- cereal advisory committee
- grass and legume advisory committee
- potato advisory committee
- mint advisory committee
- forest tree seeds advisory committee
- horticulture advisory committee
- seed trade representative

Cereal Advisory Committee

- wheat producers (three)
- seed dealers (three)
- OSU cereal breeder
- Extension cereal specialist
- county Extension agent
- Foundation Seed manager*
- Seed Certification manager*
- Seed Lab manager*

Grass and Legume Advisory Committee

- seed producers (six)
- seed dealers (six)
- county Extension agents (two)
- Extension seed specialist
- OSU plant breeder
- Foundation seed manager*
- Seed Certification manager*
- Seed Lab manager*

Potato Advisory Committee

- Potato Commission
- growers (various geographic areas)
- OSU researcher
- Extension specialist
- county Extension agent
- Foundation Seed manager*
- Seed Certification manager*

Mint Advisory Committee

- OSU mint breeder
- certified mint growers
- Essential Oil Growers Assoc.
- OSU plant pathologist
- county Extension agent
- Crop Science dept. head*
- Foundation Seed manager*
- Seed Certification manager*

Forest Tree Seeds Advisory Committee

- Tree Seeds Certification Assoc.
- Seed Certification manager*
- Seed Lab manager*

Horticulture Advisory Committee

(to be organized)

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* Ex officio or nonvoting members.

** Shown for coordination purposes only. Seed Lab not subject to board control.

Appendix F AgIII-XIII-71

Oregon Weed Control Recommendations for Grass and Legume Seed Crops

STATE-WIDE

• **Problem:** *The Control of Weedy Annual Broadleafs and Certain Broadleaf Perennial Weeds in New and Established Stands of Grass Seed Crops Under Both Eastern and Western Oregon Conditions*

Chemical: 2,4-D; MCPA; dicamba; bromoxynil; 2,4-D + dicamba; or MCPA + dicamba

Spray Mixture: Use ½ to ¾ pound of 2,4-D amine, oil soluble amine, acid or ester, or diamine or use ½ to 1 pound MCPA amine, ester, or sodium salt in 10 or more gallons of water per acre by ground application, or at least 2 gallons per acre by airplane. For dicamba-2,4-D combinations, use ¼ pound of dicamba and ½ pound of 2,4-D per acre. For bromoxynil use ⅜ to ½ pound (1½ to 2 pints) in 20 gallons of water per acre.

Time of Application: New seedings in the spring should not be sprayed with 2,4-D, MCPA, or dicamba-2,4-D before the grass has 5 leaves (usually 4-5 weeks after emergence). When irrigation is used, the grass can be sprayed after the 2-leaf stage. Bromoxynil can be sprayed after the grass has emerged but before the broadleaf weeds are past the 4-leaf stage of growth. Use the ½ pound rate of bromoxynil if the weeds are larger than the 4-leaf stage, but less than 6 inches in height and before flower formation.

Dicamba-2,4-D combinations are now registered for tank mixes.

Do not graze dairy animals or animals being finished for slaughter in field treated with 2,4-D or dicamba within 7 days of application. Do not graze fields treated with MCPA within 14 days after application.

Do not graze field sprayed with bromoxynil for 30 days following application.

When application is made to fall seeded stands in western Oregon, ½ pound 2,4-D or MCPA per acre or ¼ pound dicamba per acre may be used any time after the 2-leaf stage.

For weed control in established stands, applications may be made either in the fall or early spring. Application should be made prior to the time seed heads appear in the boot.

Cautions: Care should be exercised in the application of 2,4-D to prevent drifting of spray particles or vapors on to sensitive crops. Small amounts of drift can be injurious to most shade trees, ornamentals, and such crops as grapes, tomatoes, cole crops, and similar succulent broadleaf type crops. Consideration should be given to wind velocity, wind direction, and spray pressure to avoid injury. Where there is danger to sensitive crops, high volatile esters should not be used. The amine or acid form is safest in such conditions. Vapors can drift for many miles. See "Chemicals and Properties," 2,4-D section, to determine 2,4-D esters classified as "low volatile." Because of volatility problems, use of the isopropyl ester is illegal in Oregon.

Do not use oil as a carrier for air application, as damage may result. Since oats are more sensitive to 2,4-D compared with other cereals, only the amine form, at a rate no greater than ½ pound per acre, should be used.

Where nitrogen fertilizer solutions are used with 2,4-D, serious foliage damage may occur. This is usually temporary in nature. Under some growing conditions, 2-4-D or MCPA may injure bentgrass at the higher rates of application. Since bentgrass is more sensitive than other grasses, application to new stands should be delayed until the bentgrass seedlings are well established.

2,4-D, MCPA and dicamba slow up root development of seedling grasses. If it is necessary to spray new stands of grasses when they are quite small, it is very important to give frequent irrigations until the root injury has been outgrown.

• **Problem:** *Control of Sheep Sorrel, Dog Fennel, and Some Other 2,4-D Resistant Weeds in Established Grass Seed Fields*

Chemical: dicamba

Spray Mixture: Use ¼ to ½ pound (½ to 1 pint) in 10 to 20 gallons of water per acre for sheep sorrel control.

Time of Application: Apply on sheep sorrel after there is considerable foliage growth, usually between late November and March 15. Spring application controls seedling sheep sorrel plants better than fall application. On dog fennel and other annual weeds, spray while weeds are small and use ½ pound of active chemical per acre.

Cautions: Use the same drift precautions as for 2,4-D.

This treatment may not kill all established sheep sorrel, but will prevent any seed set and kill most plants. Use the lower rate for sheep sorrel or in spring treatment. Spring treatment must be made early or seed yield may be reduced.

Do not graze dairy animals in field treated with dicamba within 7 days of application.

On established grass seed fields which have been burned, it is not advisable to apply dicamba in the fall with simazine, atrazine, diuron, propham or chlorpropham. Usually sheep sorrel is not making fall growth when these herbicides are applied. On new seedings of perennial grasses which have not been burned, dicamba can be applied with diuron where applicable.

• **Problem:** *The Use of Activated Carbon to Protect Grasses Planted for Seed Production From Diuron Applied Preemergence (western Oregon only)*

Chemical: Activated carbon,* diuron

Spray Mixture: Activated carbon: Mix activated carbon with water at a ratio of ½ pound per gallon. Apply the resulting slurry at the rate of 300 pounds carbon per acre in a band 1

Mention of a trademark name of a proprietory product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or Oregon State University and does not imply their approval to the exclusion of other products that also may be suitable.

* Gro-Safe is the brand name of the presently available carbon product which has been most satisfactory in research trials.

inch wide directly over the seeded row. (Where the grass is seeded in rows spaced 12 inches apart, only 1/12 of the field surface is treated with carbon. Thus, the above rate is equivalent to 25 pounds carbon per acre seeded.)

Diuron: Apply as a broadcast application with a fixed boom sprayer at the rate of 2.5 to 3.0 pounds per acre. Use the lower rate for light soils (sandy loams, loams) and the higher rate for heavy soils (clay loams, clays).

Time of Application: Activated carbon: Apply at planting time. Diuron: Apply after planting and before rains or sprinkler irrigation.

Remarks: Prepare a smooth, firm, trash-free seedbed before planting. At least 1 inch of overhead moisture, rainfall or sprinkle irrigation is required within 2 weeks after the diuron is applied to activate the herbicide. Special seeding, spraying and carbon-mixing equipment is available through spray material dealers.

Cautions: Do not treat grass seed fields which will be replanted to any crop within 2 years as crop injury may result. This treatment will not control volunteer winter cereals, wild oats or downy brome.

PERENNIAL RYEGRASS

- **Problem:** *Control of Annual Bluegrass, Rattail Fescue, Volunteer Small Grains, Wild Oats, Common Chickweed, and Other Weeds in New Plantings of Perennial Ryegrass in Western Oregon.*

Chemical: ethofumesate

Spray Mixture: Use 0.75 to 1.9 pounds active ethofumesate per acre in 5 or more gallons of water by air or 10 or more gallons of water by ground equipment. Use the higher rate where weeds are emerged or where rattail fescue is present.

Time of Application: Apply after the ryegrass is planted but no later than the 4-leaf stage of the weeds. Rattail fescue must be treated no later than the 2-leaf stage. In fields that are planted with carbon bands and treated with diuron, delay ethofumesate applications until sufficient rainfall (2" or more) has occurred to dissipate the carbon band. Applications made sooner may not control weeds under the carbon bands.

Remarks: Ethofumesate is much more effective when applied to a firm, fine seedbed that is free from crop residue. The soil surface should be moist at the time of application, and rainfall or overhead irrigation soon after application increases effectiveness.

Caution: Do not graze treated crop. Do not cut hay or use straw or screening for feed or forage.

- Problem: *The Control of Weedy Annual Grasses Such As Annual Ryegrass, Rattail Fescue, and Similar Species in Established Stands of Perennial Ryegrass in Western Oregon*

Chemical: propham or chlorpropham

Spray Mixxture: Use 3 pounds of propham per acre in 10 to 20 gallons of water by ground application, or in at least 3 gallons of carrier by air application. Chlorpropham should not be used at more than 2 pounds per acre in the same volume of carrier as propham.

Time of Application: Application should be made after fall rains have started the germination of annual grass weed seed. Application should be made prior to November 1. Use propham only during rainy weather when soil is moist and temperatures cool.

Cautions: Only fields which have been harvested for seed at least once should be sprayed. New stands may be seriously injured by these treatments. Chlorpropham is generally preferred because it gives control over a longer period of time. Propham is more effective on ripgut brome and wild oats. It is effective preemergence on annual bluegrass, but short residual life will often cause failure to control late germinating plants. On other species, the two materials at the rates suggested are approximately equal. This treatment is not effective on many broadleaf weeds and perennials such as wild garlic.

Chemical: atrazine

Spray Mixture: Use 1½ pounds of 80% commercial atrazine (1.2 pounds active) per acre in 15 or more gallons of water in a sprayer with mechanical agitation.

Time of Application: As soon as fall rains start. Treatment before weed germination or while weed seedlings are still small, gives the best control. Fall planted ryegrass should not be treated the following fall until after October 15.

Cautions: Apply only to well established fields that have been harvested for seed at least once. Do not graze for 10 days following treatment. Allow 60 days before cutting hay. This treatment may cause damage on first-year stands. Do not use more than 2 consecutive years on the same seed field. Atrazine at selective rates does not control wild garlic. Garlic fields should receive 2,4-D sprays. (See Garlic spraying in *Control of Common Weeds* section.)

Chemical: ethofumesate

Spray Mixture: Use 0.75 to 1.9 pounds active ethofumesate per acre. Apply in 5 or more gallons of water per acre for aerial applications and in 10 or more gallons of water per acre for ground applications. Use the higher rate where weeds are emerged and where rattail fescue is present.

Time of Application: Apply to a moist soil surface after the fall rains start. Applications should be made preemergence to the weeds or before the weeds reach the 4-leaf stage. Rattail fescue is more resistant and should be treated no later than the 2-leaf stage.

Remarks: For best results, all crop residue should be removed from the field by burning or mechanical means before treatment. The soil surface should be moist at the time of application and followed by rainfall.

Cautions: Ethofumesate does not control volunteer perennial ryegrass or annual ryegrass. To control these species, it will be necessary to apply atrazine, propham, or chlorpropham in addition to ethofumesate. Do not tank mix. Do not cut for hay or use straw or screenings for feed or forage.

- Problem: *Control of Wild Oats in New or Established Stands of Perennial Ryegrass.*

Chemical MSMA

Spray Mixture: Apply 4.5 to 6.0 pounds per acre MSMA that includes a surfactant.

Time of Application: Applications can be made anytime after the wild oats have emerged and before the grass reaches the boot stage. MSMA enters the wild oat plants through the foliage. It is not effective through the soil or on ungerminated seeds. Thus, treatment should be delayed in new plantings until maximum wild oat emergence has occurred.

Cautions: Cool temperatures (below 65°) reduce the effectiveness of MSMA. Applications should be made when it is anticipated that several days with clear skies and temperatures 65° or above will follow the applications. Do not use more than one application per year. To avoid marked reduction in seed production, do not apply after the grass reaches the boot stage. Do not graze fields or feed hay or seed residue from treated fields.

ANNUAL RYEGRASS

- **Problem:** *Control of Annual Bluegrass, Rattail Fescue, Volunteer Small Grains, Wild Oats, and Certain Other Winter Annual Weeds in Annual Ryegrass*

Chemical: ethofumesate

Spray Mixture: Use same recommendations indicated for new plantings of perennial ryegrass.

Time of Application: Use same recommendations as for new plantings of perennial ryegrass.

Cautions: Same as for new plantings of perennial ryegrass.

- **Problem:** *Control of Wild Oats in New or Established Stands of Annual Ryegrass*

Chemical: MSMA

Refer to preceding section under Perennial Ryegrass for complete information and instructions.

HIGHLAND OR ASTORIA BENTGRASSES

- **Problem:** *The Control of Weedy Annual Grasses in Established Stands of Bentgrasses in Western Oregon*

Chemical: propham or chlorpropham

Spray Mixture: Use 3 pounds of chlorpropham or 4 pounds of propham in 10 or more gallons of water per acre by ground application.

Time of Application: Application should be made after the first fall rains start germination of weed seeds. Application should be made before November 1. Use propham only during rainy periods when soil is moist and temperatures cool.

Cautions: Spray only fields that have been harvested for seed once. These treatments may seriously injure new stands.

Chemical: diuron

Spray Mixture: Use 2 to 3 pounds of 80% commercial product (1.6 to 2.4 pounds active diuron) in 20 or more gallons of water in a sprayer with good mechanical agitation.

Time of Application: Application should be made after the first fall rains start germination of weed seeds. Treatment should be made before the weeds are well established. Spraying normally should be done between October 1 and the middle of November. If straw residues have been burned on the field, the higher rate of application is necessary. Under these conditions, if diuron is used, rates as high as 4 pounds per acre may be necessary to give good weed control. For best results, spread unburned chaff or straw by harrowing, or going over the field with a rotary chopper.

Cautions: Apply only to well established grasses that have been harvested for seed at least once. Since diuron at high rates is a soil sterilant, care should be exercised while making applications to avoid overdoses when stopping, starting, or turning. Good mechanical agitation is necessary to keep this material in suspension. Do not use this treatment on sandy soils as injury may result. Diuron may cause temporary kill of top growth.

Chemical: simazine

Spray Mixture: Use 2½ pounds of 80% commercial simazine (2 pounds active ingredient) per acre in 15 or more gallons of water in a sprayer with good mechanical agitation.

Time of Application: Application should be made as soon as fall rains start. Early spraying before weeds germinate is important. Spread unburned straw and chaff with harrow or chopper before spraying.

Cautions: Apply only to well established grasses that have been harvested for seed at least once. Use a sprayer with mechanical agitation. Will control most annual grasses and broadleaf type weeds. Do not graze for 30 days after spraying or cut hay for 60 days following spraying.

Chemical: ethofumesate

Spray Mixture: Use 1.0 to 1.5 pounds active per acre in 5 gallons or more of water by air or 10 gallons or more of water by ground equipment.

Time of Application: Apply to a moist soil surface after the fall rains start. Apply preemergence to the weeds or before the weeds reach the 4-leaf stage. Rattail fescue is more resistant and should be treated no later than the 2-leaf stage.

Cautions: Spray only fields that have been seeded at least 12 months. Remove all crop residue by burning or mechanical means before spraying. Ethofumesate does not control annual or perennial ryegrass. If these species are present, one of the other herbicides registered for use in these crops should also be used. Do not tank mix. Do not graze the treated crop with livestock. Do not cut for hay or use straw or screenings for feed or forage.

PENNCROSS BENTGRASS

- **Problem:** *The Control of Annual Bluegrass in Established Stands of Penncross Bentgrass in Western Oregon*

Chemical: bensulide

Spray Mixture: Use 8 to 10 pounds (2 to 2½ gallons) per acre in 10 to 50 gallons of water per acre.

Time of Application: Apply after straw removal, before the first postharvest irrigation and before weed germination.

Cautions: Do not feed straw to livestock. Do not graze livestock in treated fields.

Chemical: ethofumesate

Spray Mixture: Use same recommendations indicated for Highland and Astoria bentgrass.

Time of Application: Use same recommendations indicated for Highland and Astoria bentgrass.

Cautions: Do not graze treated fields with livestock. Do not cut for hay or use straw or screenings for feed or forage.

VARIETIES OF KENTUCKY BLUEGRASS

- **Problem:** ***The Control of Weedy Annual Grasses and Broadleaf Weeds in New or Established Stands of the Above Grasses Grown in Western Oregon***

Chemical: diuron

Spray Mixture: Use 2 to 4 pounds of 80% product (1.6 to 3.2 pounds active diuron) in 20 or more gallons of water per acre in a sprayer with good mechanical agitation.

A split application of diuron is usually more effective in controlling annual bluegrass (*Poa annua*) than a single application in the fall. In a split application apply 3 pounds of 80% product (2.4 pounds active diuron) during the last two weeks of October, followed by 1½ to 2 pounds of 80% product (1.2 to 1.6 pounds active diuron) between January 1 and February 1.

Time of Application: Application should be made in the fall as soon as fall rains start the germination of weed seeds. Spray before the weeds are well established, usually mid-November. Do not spray spring planted stands before October 15. Spray only well established stands planted before April 1. Spread unburned chaff and straw with a harrow before application. The control of annual bluegrass may require harrowing with a pasture-type harrow after field burning to scatter unburned chaff. Such fields may require a second burning with a field burner before applying the fall herbicides.

Cautions: New stands of bluegrass should be well established from spring seedings if diuron is going to be used in the fall. No more than 2 pounds per acre should be used on new stands.

Where crop residues have been burned leaving considerable ash, at least 3 pounds of diuron will be necessary for weed control. Rates as high as 4 pounds may be required for adequate weed control. If 3 or 4 pounds of diuron are applied for 2 or more consecutive years, or if split applications are used, the bluegrass may be severely injured or eliminated from low areas of the field where water stands for long periods of time during the winter or early spring months. It is important to use a sprayer with good mechanical agitation to prevent settling of the diuron. Since diuron is a soil sterilant at high rates, care should be exercised not to get overdoes when starting, stopping, and turning. Precision spraying by using markers at the end of the boom or flagmen, and care to avoid plugged nozzles is important to prevent skips that will give contamination with annual bluegrass, etc. To avoid weeds in spray skip areas, spray each field twice with half rate, using a marker so the middle of the sprayer centers on the area covered by the end of the boom in the first application.

Chemical: propham or chlorpropham

Spray Mixture: Use 3 pounds of chlorpropham or propham in 10 to 20 gallons of water per acre.

Time of Application: Make application after the first fall rains and prior to November 1. Use propham only during rainy weather when soil is moist and temperature cool.

Cautions: Apply only to well established fields that have been harvested for seed at least once.

Propham or chlorpropham are more effective on ripgut brome and wild oats than diuron and should be used where these weeds are the primary problem. Propham and chlorpropham may not give satisfactory control of late germinating annual bluegrass in perennial bluegrass fields because of a short residual life.

Chemical: ethofumesate

Spray Mixture: Use same recommendations indicated for Highland and Astoria bentgrass.

Time of Application: Use same recommendations indicated for Highland and Astoria bentgrass.

Cautions: Same as indicated for Highland and Astoria bentgrass.

- **Problem:** ***Control of Wild Oats in New or Established Stands of Kentucky bluegrass.***

Chemical: MSMA

Spray Mixture: Use same recommendation indicated for perennial ryegrass.

Time of Application: Use same recommendation indicated for perennial ryegrass.

TALL FESCUE AND ORCHARDGRASS

- **Problem:** ***The Control of Weedy Annual Grasses and Broadleaf Weeds in Established Stands in Western Oregon***

Chemical: simazine

Spray Mixture: Use 2½ pounds of 80% (2 pounds active) simazine in 15 or more gallons of water. Especially effective for control of wild oats, ripgut brome and seedling chess. Will not control established clumps of chess.

Time of Application: As soon as the first fall rains start. Early application is important.

Cautions: Apply only to well established stands that have been harvested for seed at least once. Use only sprayers with mechanical agitation. Allow 30 days between application and grazing to livestock. Allow 60 days between application and cutting for hay.

Chemical: propham or chlorpropham

Spray Mixture: Use same recommendation indicated for bluegrasses.

Time of Application: Use same recommendation indicated for bluegrasses.

Do not use propham or chlorpropham on Kenhy (tall fescue ryegrass hybrid) variety as it appears to lack the tolerance expressed by other tall fescue varieties.

Chemical: diuron

Spray Mixture: Use same recommendation indicated for bluegrasses.

Time of Application: Use same recommendation indicated for bluegrasses.

FINE FESCUES (Illahee, Rainier, Pennlawn, Chewings, and Related Varieties)

- **Problem:** ***The Control of Weedy Annual Grasses Such as Ryegrass, Rattail Fescue, and Silver Hairgrass in Established Stands in Western Oregon***

Chemical: propham or chlorpropham

Spray Mixture: Use 3 pounds of propham or 2 pounds of chlorpropham per acre in 10 or more gallons of water.

Time of Application: The time of application with propham and chlorpropham on fine fescues is extremely critical. The seed crop may be seriously injured if proper timing is not followed. Application of these two materials should not be made later than October 20. Where fall rains do not occur in sufficient quantities to allow treatment prior to October 20, the use of propham or chlorpropham will usually cause severe damage to the seed crop. To minimize damage to the seed crop, good fall fertility should be available. Use regular propham only during rainy periods when the soil is moist and temperature cool.

Cautions: The fine fescues are more sensitive to propham and chlorpropham than other common grass seed crops. Special care should be taken to keep from applying more chemical than the amount recommended.

Good agitation is important to be sure of uniform application.

Stands should be harvested for seed at least once before they are sprayed. The spray damage resulting from late applications can exceed the damage from the presence of weeds. The seriousness of the weed problem may be used as the deciding factor.

Chemical: simazine

Spray Mixture: Use 2½ pounds of 80% commercial product (2 pounds active) per acre in 15 or more gallons of water. Especially useful for control of wild oats, ripgut brome and seeding chess.

Time of Application: As soon as the first rains start. Early application is important.

Cautions: Apply only to well established fields that have been harvested for seed at least once. Use only sprayers with mechanical agitation. Allow 30 days between application and grazing livestock.

Spread unburned chaff and straw with a harrow for better control.

- **Problem:** *Control of Wild Oats in Fine Fescues*

Chemical: MSMA

Spray Mixture: Use same recommendation indicated for perennial ryegrass.

Time of Application: Use same recommendation indicated for perennial ryegrass.

- **Problem:** *Control of Downy Brome (Cheatgrass), Rattail Fescue, and Other Weedy Annual Grasses and Broadleaf Weeds in Eastern Oregon Perennial Grass Seed Fields (Bluegrasses, Fescues, and Other Lawn and Pasture Grasses)*

Chemical: dicamba

Spray Mixture: Use 3 pounds (3 quarts) in 10 or more gallons of water per acre.

Time of Application: Spray within 10 days after the first fall irrigation, or fall rain sufficient to start germination of weeds. Spraying while soil is still moist has given best results.

Cautions: Spray only well established stands of grass. Best control will be obtained only if the fields have been burned, and unburned chaff and straw spread by going over the field with a pasture harrow or similar implement.

Do not graze dairy animals within 90 days of application.

Do not graze animals within 30 days of slaughter.

- **Problem:** ***Chemical Seedbed Preparation to Aid in the Establishment of Small Seeded Grass Seed Crops in Western Oregon on Fields with Adequate Drainage to Permit Early Seeding***

Chemical: paraquat or a mixture of propham + 2,4-D

Spray Mixture: Use ½ pound paraquat or 4 pounds of propham plus 1 pound of 2,4-D. Where paraquat is used, add spreader recommended on the paraquat label at 1 pint per 100 gallons of spray solution.

Time of Application: Applications should be made during late November or December. If weather prevents treatment, paraquat can be used during January. If weeds are large before the January application is made, two applications of paraquat at ¼ pound per acre about 10 days apart will be more effective in killing the weeds than a single application at ½ pound per acre. Propham + 2,4-D should not be applied after January 1. Seed grasses between February 15 and March 15. If irrigation is available, seeding can be delayed. If additional germination occurs after the December treatments, paraquat can be applied just before seeding or up to the time of emergence, if the crop seed is well covered.

Cautions: These treatments will control only weeds coming from seed. Crops or weeds coming from vegetative portions of perennial plants will not be controlled. Fields should be prepared and cultivated as late in the fall as possible (at least October 15) to destroy early germinating plants. When paraquat is applied, use sprayer with rear mounted boom. Do not disturb soil after treatment, as more weed seeds will be brought to the soil surface and germinate. Some formulations of propham and 2,4-D are not physically compatible. Mix small quantities to test compatibility before mixing in sprayer. Do not graze treated areas. Do not use seed from treated areas for livestock feed. Do not use straw from treated areas for animal bedding or feed.

Follow summer weed control practices when using 2,4-D, dicamba, or bromoxynil. Also use fall herbicides for late growing fall and winter weeds. Check previous recommendations.

- **Probblem:** ***The Control of Many Annual and Perennial Grasses and Broadleaf Weeds before Establishment or Renovation of Grass Seed Crops***

Chemical: glyphosate

Spray Mixture: For annual weed control, apply .75 pounds glyphosate (1 quart) in 20 to 60 gallons of water per acre to actively growing grasses or broadleaf weeds. If weeds are over 6 inches tall, apply 1.15 pounds (1½ quarts). Apply 1.5 to 3.75 pounds glyphosate (2 to 5 quarts) in 20 to 60 gallons of water to actively growing perennial weeds. See the label for specific rates, time of application, and species controlled.

Time of application: Use before establishment or renovation of turf grass or forage grass grown for seed. For annuals, allow 3 days or more after application before tillage. For perennials allow 7 or more days.

Cautions: Do not graze or feed treated areas within 8 weeks after application.

- **Problem:** ***Killing Perennial Grass Sods with Herbicides and Summer Fallow to Clean Up Field for Winter Planting***

Chemical: dalapon

Spray Mixture: Use 10 pounds of the 85% sodium salt formulation of dalapon plus added wetting agent in 10 to 40 gallons of water per acre.

Time of Application: Apply 2 to 4 weeks prior to plowing and when perennial grasses such as bentgrass, creeping velvetgrass, quackgrass, tall fescue, and similar species are growing vigorously. Best results will usually occur from late May application followed by plowing and spring-tooth harrowing to dry out the soil and pull rhizomes and sod clumps to the surface where drying by the sun and air will finish killing the plants.

Cautions: Heavily infested fields may not be adequately killed from a single year of fallow to prevent contamination of subsequent seed crops. This is particularly true in rainy seasons which prevent complete drying of the soil.

LEGUMES

LEGUMES FOR FORAGE OR SEED
BIRDSFOOT TREFOIL

- **Problem:** ***The Control of Certain Weedy Annual Broadleaves in New Stands of Birdsfoot Trefoil***

Chemical: 2,4-DB amine

Spray Mixture: Use ½ pound of the amine form per acre in 10 to 20 gallons of water.

Time of Application: Application should be made after the trefoil has at least 2 true leaves. The weeds should be small at the time application is made.

Cautions: The same precautions relative to drift hazards should be observed with this material as for regular 2,4-D.

Birdsfoot trefoil is somewhat sensitive to this chemical and will be retarded with some distortion of leaves and stems for a period of several weeks following treatment. Apply only where weed problems are serious to the extent that 2 or 3 weeks retarded growth from the chemical will be less serious than damage caused as a result of the weed problem.

This treatment is damaging to established stands of trefoil and should be used only on young seedlings.

Do not graze or feed treated forage until 30 days after treatment.

- **Problem:** ***The Preemergence Control of Weedy Annual Grasses in New Plantings of Birdsfoot Trefoil***

Chemical: EPTC

Spray Mixture: Use 3 pounds per acre of EPTC in 20 or more gallons of water.

Time of Application: Application should be made on the seedbed prior to the final discing and harrowing. Application should be made on seedbeds dry enough to permit thorough mixing through discing two directions to a depth of 4 to 6 inches immediately after spraying.

Seeding of the birdsfoot trefoil may be done any time after the treatments have been worked into the soil.

Cautions: There are no particular precautions in the use of this material, other than to avoid contact with clothing, since the material has a very disagreeable odor which cannot be easily washed from clothing.

Chemical: benefin

Spray Mixture: Light (sandy) soils, apply 2 quarts of the 1½ pound per gallon formulation (¾ pound active) in 20 to 40 gallons of water per acre. Medium (sandy loam) soils, apply 3 quarts of the 1½ pound per gallon formulation (1.1 pounds active) in 20 to 40 gallons of water per acre. Heavy (silt or clay) soils, apply 4 quarts of the 1½ pound per gallon formulation (1½ pounds active) in 20 to 40 gallons of water per acre.

Time of Application: From 10 weeks prior to immediately prior to planting. Work the spray thoroughly into the soil by cross discing or using a rotary tiller simultaneously with or immediately after application.

Cautions: Spray only once and avoid overlapping. Do not plant wheat, barley, rye, domestic grasses, or onions for 10 months following benefin applications. Corn, oats, red beets, other root crops, and spinach should not be planted within 12 months of spraying with benefin.

- **Problem:** ***The Control of Annual Grasses and Broadleaf Weeds in Established Stands of Birdsfoot Trefoil***

Chemical: diuron

Spray Mixture: Use 2 pounds of 80% product (1.6 pounds active diuron) in 20 to 30 gallons of water per acre in a sprayer with good mechanical agitation.

Time of Application: Application should be made in the fall after the trefoil starts into winter dormancy. The normal time of application in western Oregon will be in late October or early November.

Cautions: Application should be made only on stands that are at least 1 year old. Since diuron at high rates is a soil sterilant, care should be used not to get overdosage in starting, stopping, and turning.

It is important to have good mechanical agitation to keep this material in uniform suspension.

RED CLOVER, LADINO AND OTHER WHITE CLOVERS

- **Problem:** ***The Control of Grass Type Annual Weeds and Certain Broadleaf Species in the Establishment of Red, Ladino, and White Clovers (except White Dutch)***

Preplant

Chemical: EPTC

Spray Mixture: Uses 2 to 4 pounds of EPTC per acre in 20 or more gallons of water.

Time of Application: Application should be made on the seedbed prior to the final discing and harrowing. Application should be made on soil dry enough to permit thorough mixing by discing two directions to a depth of 4 to 6 inches immediately after spraying. Seeding of the clovers may be done any time after treatments have been worked into the soil.

Cautions: There are no particular precautions in the use of this material other than to avoid contact with clothing, since the material has a very disagreeable odor which cannot be easily washed from clothing. This treatment may cause some stunting and leaf malformation of the clover during the first few weeks after emergence. This injury is temporary and rapidly outgrown.

Chemical: benefin

Spray Mixture: Light and medium soils, 3 quarts per acre (1.12 pounds active); heavy soils, 4 quarts per acre (1.5 pounds active). Formulation is a 1.5 pound per gallon formulation. Apply chemical in 5 to 40 gallons of water per acre.

Time of Application: Apply and incorporate any time within 10 weeks before planting. Do not apply after planting. Balan must be incorporated into the soil simultaneously with or immediately after application. Spray can be worked thoroughly into soil by cross discing or using a PTO rotary tiller.

Cautions: Spray only once and avoid overlapping. Do not plant wheat, barley, rye, other domestic grasses and onions for 10 months following benefin application. Milo (grain sorghum), corn, oats, red beets, sugar beets, other root crops and spinach should not be planted for 12 months following benefin application.

- **Problem:** ***The Control of Weedy Annual Grasses or Grains in New or Established Stands***

Chemical: propham or chlorpropham

Spray Mixture: Use 3 pounds of chlorpropham or 4 pounds of propham in 20 to 60 gallons of water.

Time of Application: Propham or chlorpropham may be used in the late fall or winter after the weedy grasses have germinated. When sprays have not been applied before February 1, chlorpropham should be used. Early applications are best. Clover seedlings may be treated any time after they have 2 or more true leaves. Established stands should be treated as soon as weedy annual grasses start to germinate.

Remarks: Chlorpropham or propham can make seedling clover more susceptible to winter injury.

Cautions: The use of propham and chlorpropham does not require any special precautions, other than to be sure the solution is thoroughly mixed in the spray tank before starting to spray.

Chemical: pronamide

Spray Mixture: Use .75 to 2.0 pounds active ingredient (1.5 to 4.0 pounds of 50% wettable powder) in 20 to 50 gallons of water per acre. Use the higher rate for well established grasses or volunteer grains.

Time of Application: Apply during the fall or winter to clovers which are in the trifoliate leaf stage or beyond. Apply before freeze-up in the colder areas.

Cautions: Do not graze treated fields or harvest for forage within 120 days of treatment.

Pronamide does not control winter annual broadleaf weeds such as groundsel, hawksbeard, mayweed, etc. (Composite family) which are usually a problem in western Oregon.

- **Problem:** ***The Control of Certain Weedy Broadleaf Annual and Certain Perennial Species in Either New or Established Stands of Red and White Clovers***

Chemical: 2,4-DB amine, MCPA amine, or sodium salt, or dinoseb amine

Spray Mixture: Use ¾ to 1½ pounds per acre of 2,4-DB amine or ¼ pound per acre of MCPA amine or sodium salt in 10 to 20 gallons of water. Apply dinoseb amine at the rate of 1½ pounds (2 quarts) in 30 gallons of water per acre.

Time of Application: Seedling stands may be sprayed with 2,4-DB or MCPA after they have 2 or more true leaves. On established stands, application should be made in the late fall or early spring when the weeds are small. Dinoseb is effective only on small weeds before they have more than 2 or 3 true leaves. It should be applied on clover that has at least 3 true leaves.

Do not apply 2,4-DB to established stands grown for seed.

Cautions: The precautions used to avoid drift injury to susceptible crops when using 2,4-D and MCPA should be followed. Clovers will show some stem twisting as a result of application of 2,4-DB and MCPA. This may cause retarded growth for at least 2 weeks. Dinoseb amine may cause some leaf injury to the clover. 2,4-DB sprayed fields should not be grazed for 30 days after spraying. Fields treated with dinoseb should not be grazed within 6 weeks after application.

- **Problem:** ***The Control of Winter Annual Grasses and Broadleaf Weeds in Established Red and White Clover***

Chemical: paraquat + X-77 (Oregon and Washington)

Spray Mixture: Apply ¼ to ½ pound per acre (1 to 2 pints) in 20 to 100 gallons of water per acre. Add 8 oz. of X-77 spreader per 100 gallons of water

Time of Application: Apply to well established stands between November 15 and January 15, when the crop is dormant and before spring growth starts.

Remarks: When a heavy winter annual grass population exists, split applications of propham, chlorpropham, or pronamide, which have residual activity, and paraquat may give better grass weed control than paraquat alone. Paraquat will control many annual broadleaf weeds not controlled by propham, chlorpropham, or pronamide.

Cautions: Do not graze, cut or harvest within 90 days of application. Do not apply more than once per season.

Do not apply to fall-planted red clover during the first winter. Do not apply, during the first winter, to red clover planted in the spring with a nurse crop.

- **Problem:** ***The Control of Annual Grasses and Broadleaf Weeds in Established Red Clover***

Chemical: diuron

Spray Mixture: Use 2 pounds of the 80% commercial product in 40 gallons of water per acre.

Time of Application: Apply between October 15 and December 15.

Cautions: Apply only on stands at least 9 months old and in vigorous condition. Use only a sprayer with mechanical agitation.

ALFALFA

- **Problem:** *The Control of Grass-type Annual Weeds and Certain Broadleaf Species in Establishment or on New Stands of Alfalfa*

Chemical: EPTC

Spray Mixture: Use 2 to 4 pounds per acre of Eptam in 20 or more gallons of water. Use 2 pounds on light sandy soil. Use 4 pounds on heavy soil when nutgrass or quackgrass is to be controlled. On other sites use 3 pounds.

Time of Application: Application should be made on the seedbed prior to final discing and harrowing. Application should be made on soil dry enough to permit thorough mixing by discing in two directions to a depth of 4 to 6 inches immediately after spraying. The alfalfa may be seeded any time after the treatment has been worked into the soil.

Cautions: There are no particular precautions in the use of Eptam, other than to avoid contact with clothing the material has a very disagreeable odor which cannot be easily washed from clothing.

Temporary stunting and leaf distortion on the alfalfa may occur, but is quickly outgrown.

Chemical: benefin

Spray Mixture: Light and medium soils, 3 quarts per acre (1.12 pounds active); heavy soils, 4 quarts per acre (1.5 pounds active). Formulation is a 1.5 pound per gallon formulation. Apply chemical in 10 to 40 gallons of water per acre.

Time of Application: Apply and incorporate and time within 10 weeks before planting. Do not apply after planting. Balan must be incorporated into the soil simultaneously with or immediately after application. Spray can be worked thoroughly into soil by cross discing or using a PTO rotary tiller.

Cautions: Spray only once and avoid overlapping. Consult the label for restrictions on planting sensitive crops.

Chemical: glyphosate

Spray Mixture: Apply 0.75 pounds glyphosate (1 quart) in 20 to 60 gallons of water to actively growing annual grasses or broadleaf weeds. If weeds are over 6 inches tall, apply 1.15 pounds, (1½ quarts). Apply 1.5 to 3.75 glyphasate (2 to 5 quarts) in 20 to 60 gallons of water to actively growing perennial weeds. See the label for specific rates, time of application, and species controlled.

Time of Application: Apply before establishment of alfalfa using conventional seeding systems or when overseeded into a cover crop. When alfalfa is overseeded, this product must be applied before planting a labeled cover crop. For annuals, allow 3 days or more after application before tillage. For perennials, allow 7 or more days.

Chemical: profluralin

Spray Mixture: Fine soils—2.0 pts. (1.0 lb. a.i. per acre); medium soils—1.5 to 2.0 pts. (0.75 to 1.0 lb. a.i./acre); coarse soil—1.0 to 1.5 pts. (0.5 to 0.75 lb. a.i./acre). Formulated as a 4 lb. per gallon EC. Apply in 10 to 40 gallons per acre.

Time of Application: Apply at the recommended rate and incorporate within four hours. Do not apply after planting. Good incorporation with a PTO tiller or a disc harrow, rolling cultivator, or mulch treader operated in two directions is essential for optimum results.

Cautions: Spray only once and avoid overlapping. Do not use if a nurse crop such as oats is to be planted or if an alfalfa-grass mixture is to be seeded. Consult the label for restrictions on planting sensitive crops.

Chemical: propham or chlorpropham

Spray Mixture: Use 4 pounds of propham or chlorpropham in 10 to 20 gallons of water per acre.

Time of Application: Apply as the newly established alfalfa is starting dormancy in November or December. Alfalfa should have at least 3 true leaves. Use propham only during cool rainy weather.

Cautions: No special precautions are necessary.

Remarks: Combinations of either herbicide with dinitro will improve broadleaf weed control. See the subsequent section dealing with dinoseb application.

- **Problem:** ***The Control of Volunteer Grains or Grains Planted for Soil Stabilization in Sandy Soils of Eastern Oregon.***

Chemical: propham

Spray Mixture: Use 3 to 4 pounds per acre (3 to 4 quarts of the 4 pound per gallon formulation). It should be watered in by rainfall or sprinkler irrigation, immediately after application if the weather is warm or within 2 days in cool weather.

Time of Application: Postemergence applications should be made after the alfalfa has at least 3 true leaves. Alfalfa need not be dormant. IPC is much more effective in cool weather.

Cautions: Weather conditions are important in the use of propham. Cool weather and proper water management are critical for best results.

- **Problem:** *The Control of Certain Weedy Annual Broadleaf Weeds in Established or New Stands of Alfalfa*

Chemical: 2,4-DB or dinoseb amine or ammonium salt

Spray Mixture: Use 1 pound of the 2,4-DB amine or ½ pound of 2,4-DB ester in 10 to 20 gallons of water per acre, or 1½ pounds (2 quarts) of dinoseb amine or ammonium salt in 30 gallons of water per acre.

Time of Application: Apply as soon as the alfalfa has 2 to 3 true leaves. It is important that application be made before the weedy annuals have more than 2 to 3 true leaves.

Cautions: The same precautions as for 2,4-D should be followed with the use of 2,4-DB. Do not feed forage treated with 2,4-DB within 30 days of treating time, or dinoseb treated within 60 days.

- **Problem:** *Control of Perennial Grasses in Established Alfalfa*

Chemical: pronamide

Spray Mixture: Use 1.0 to 2.0 pounds active ingredient (2.0 to 4.0 pounds of the 50% product) in 20 to 50 gallons of water per acre. The higher rates should be used in areas with heavier soil types.

Time of Application: Apply during the fall or winter when good soil moisture is present and further precipitation is expected. Apply before freeze-up in the colder areas. Applications made between November 15 and December 15 generally have given best results.

Cautions: Do not graze treated fields or harvest for forage within 25 days of 3-pound and 45 days of 4-pound treatment. Pronamide does not control some winter annual broadleaf weeds such as groundsel, hawksbeard, mayweed, etc. (Composite family).

- **Problem:** ***The Control of Both Grass and Broadleaf Type Annuals in Established Alfalfa***

Chemical: paraquat + X-77

Spray Mixture: Apply ⅜ to ¾ pound per acre (1.5 to 3 pints) in 20 to 60 gallons of water per acre. Add 8 oz. of X-77 spreader per 100 gallons of water.

Time of Application: Apply to established stands after the last fall cutting when the crop is dormant and before spring growth starts, November 15-January 15.

Remarks: Under conditions of heavy weed infestations or when weeds are too large to be effectively controlled with paraquat, combinations with a soil residual herbicide have been effective. Propham, chlorpropham, and pronamide can be used to control additional grasses. Diuron and simazine will extend control of many annual grass and broadleaf weeds.

Cautions: Do not graze, cut or harvest treated areas within 90 days of treatment. Do not apply if regrowth is more than 2" tall. Observe application date restrictions when applying combinations of paraquat and soil residual herbicides.

Note: Combinations of paraquat and the residual herbicides diuron, simazine, propham, metribuzin, or pronamide have provided excellent control of annual weeds, particularly in heavily infested fields and when weeds are large. These treatments should be applied in the fall or early winter or as indicated on the label for the residual herbicides.

Chemical: diuron

Spray Mixture: Use 2 to 3 pounds of 80% diuron (1.6 to 2.4 pounds active) in 20 to 30 gallons of water in a sprayer that has mechanical agitation.

Time of Application: Application should be made when the alfalfa starts into winter dormancy in late October through early December. It is important for this material to be applied only on established stands that have had one year's hay production.

Cautions: Since diuron does not go into solution, a sprayer with good mechanical agitation which delivers at least 20 gallons of water per acre should be used. Care should be taken not to slow up or allow diuron to run out at excessive rates when stopping and starting. This material is a soil sterilant at high rates of application.

Chemical: simazine

Spray Mixture: Use 1 to 2 pounds of 80% commercial (.8 to 1.6 pounds active) simazine in 20 or more gallons of water in a sprayer that has mechanical agitation. Do not exceed 1 pound per acre on sandy or gravel-type soils, such as Ephrata or Ritzville.

Time of Application: Application should be made when the alfalfa starts into winter dormancy in late October through early December. It is important for this material to be applied only on established alfalfa that has had at least one year's growth. Weeds are often too large after Jan. 1 for consistent results.

Cautions: This treatment will sometimes cause a slight amount of yellow leaf symptoms on sandy soils during early spring growth. This does not appear to damage the alfalfa. Applications should be made only with a sprayer with good mechanical agitation which delivers at least 20 gallons of water per acre. Care should be taken not to slow up or allow simazine to run out at excessive rates when stopping and starting. This material is a soil sterilant at higher rates of application. Allow 30 days between last application and grazing to dairy, beef cattle, and sheep; and 60 days between application and cutting for hay.

Chemical: terbacil

Spray Mixture: Apply ½ to 1½ pounds active per acre as a broadcast spray. Use the lower rate on coarse soils and the higher rate on finer soils.

Time of Application: Make a single application in the fall after plants are dormant or in spring before new growth starts.

Cautions: Apply only to alfalfa established 1 year or more. Do not use on seedling alfalfa or grass-alfalfa mixtures. Use at least 40 gallons of water and be sure to provide uniform coverage of the ground. Shut off booms while turning, slowing, or stopping to avoid injury to crop. Moisture is necessary to actuate the chemical. For best results, ½ to 1 inch of rainfall or sprinkler irrigation should be applied within two weeks after application. Do not plant treated area to other crops within 2 years of last application as injury may occur.

Chemical: metribuzin

Spray Mixture: Use ⅜ to 1 pound active per acre (¾ to 2 pounds of 50% formulation) in 20 to 40 gallons of water.

Time of Application: Apply after alfalfa goes dormant in the fall until before growth starts in the spring.

Cautions: Do not graze or harvest within 28 days after application. See product label for full instructions and crop rotation recommendations.

Remarks: The higher rates will provide at least partial control of dandelion and some perennial grasses.

Chemical: dinoseb (General)

Spray Mixture: Use 1½ to 3 quarts in 5 to 20 gallons of diesel oil for aerial applications or 10 to 60 gallons of diesel oil in water to make 100 gallons per acre for ground applications.

Time of Application: Apply to established stand during the winter dormant season to control winter annual weeds or immediately after cutting during the growing season before regrowth starts for summer annual weeds.

Cautions: Do not graze or feed forage from treated areas within 6 weeks after application.

Chemical: pronamide

Spray Mixture: Use 0.75 to 1.5 pounds active ingredient (1.5 to 3.0 pounds of 50% wettable powder) in 20 to 50 gallons of water per acre. Use the higher rates for well established grasses or volunteer grains.

Time of Application: Apply during the fall or winter when good soil moisture is present and further precipitation is expected. Apply before freeze-up in the colder areas.

Cautions: Do not graze treated fields or harvest for forage within 120 days of treatment.

Pronamide does not control some winter annual broadleaf weeds such as groundsel, hawksbeard, mayweed, etc. (Composite family.)

Chemical: propham or chlorpropham

Spray Mixture: Use 3 to 4 pounds in 10 or more gallons of water per acre.

Time of Application: During the dormancy period of the alfalfa.

Cautions: Be sure mechanical agitation is used with non-emulsifiable formulations. These compounds generally are more effective on annual grasses.

Remarks: Combinations of either herbicide with dinitro will improve broadleaf weed control. See the preceding section concerning dinitro application.

- **Problem:** ***The Control of Barnyardgrass and Similar Summer Grasses in Established Alfalfa***

Chemical: trifluralin

Spray Mixture: Light soil, 1½ pints of 4 pound per gallon formulation (¾ pound active) in 5 to 40 gallons of water per acre. Medium soils, 2 pints of 4 pound per gallon formulation (1 pound active) in 5 to 40 gallons of water per acre. Heavy soils, 2 pints (1 quart) of 4 pound per gallon formulation (1 pound active) in 5 to 40 gallons of water per acre.

Time of Application: Apply over top of established plantings during dormant period or after removal of foliar growth and incorporate simultaneously or immediately after application with equipment that will insure a minimum of damage to the established crop.

Cautions: Spray only once and avoid overlapping. Do not plant sugar beets, red beets, or spinach for 12 months after trifluralin spring application or 14 months after trifluralin fall application. Do not plant sorghum (milo), corn or oats for 14 months after trifluralin spring application or 16 months after trifluralin fall application. Do not plant any of these crops for 18 months after trifluralin spring application or 20 months after trifluralin fall application to land that has not been irrigated. Cool wet weather conditions during the early stages of growth may increase the possibility of injury to sorghum.

DODDER CONTROL IN ALFALFA

- **Problem:** ***The Control of Small Scattered Patches of Dodder in Alfalfa***

Treatment: Destroy the dodder and the host plant to which the dodder is attached by (1) burning the patch with a hand-operated propane weed burner; (2) spraying the patch with diesel oil or other fuel oil that has been fortified with dinoseb; and (3) cutting the patch with a scythe or other hand implement and removing it from the field.

Spray Mixture: If the dinoseb fortified oil is used, mix 1 pint of dinoseb to 50 gallons of oil. Use enough spray to give complete coverage of the host plant and the dodder. High spraying pressures aid in penetrating the foliage.

Cautions: Regardless of the method of spot treatment used, the following precautions are needed for success: (1) Treat the infested patches as soon as you can locate them, preferably before seed begins to form. (2) Treat several feet beyond the apparent edge of each patch to kill dodder stands that reach out from the main patch and are hard to see. (3) Patrol the field at frequent intervals to spot new patches as they develop. (4) Revisit all treated spots at 2-week intervals during the remainder of the season to kill any dodder plants that may have survived the treatment and to kill new ones that may have come from seed. (5) Mark the treated areas so they can be relocated the following year and inspected for dodder.

- **Problem:** ***The Control of General Infestation of Dodder in Alfalfa Fields***

Chemical: chlorpropham

Rate of Chemical: Apply 6 pounds active material per acre in granular form. For second crop seed, a second 6 pounds per acre may be needed.

Time of Application: After dodder seed germinates but before attachment to the alfalfa plant. Suggested order and dates of field management for dodder control on irrigated land:

1. Fall irrigate if possible.

2. Surface till to encourage uniform dodder germination and to destroy early germinated dodder seedings—approximately March 15 to April 10.

3. Irrigate approximately April 10.

4. Apply 30 pounds of 20% granular chlorpropham (6 pounds active) approximately April 15. (Southern Oregon, apply chlorpropham from February 20 to March 15.) For best results, the alfalfa forage should be 4 to 10 inches tall when sprayed.

5. Harvest hay approximately May 15.

6. Surface till fields approximately May 22 if the soil surface is moist and the dodder is emerging.

7. Irrigate approximately May 25.

8. Apply 6 pounds active granular chlorpropham approximately May 28. Items 5 and 6 apply only when a crop of hay is removed.

Remarks: Seldom is 100% dodder control obtained by field treatment. Growers should patrol fields in search of dodder patches which should be spot treated.

Chemical: pronamide.

Rate of Chemical: Apply 1.0 to 2.0 pounds active ingredient (2 to 4 pounds of product) per acre. Use 1.5 to 2.0 pounds active ingredient per acre in furrow, rill or sprinkler irrigated fields and 1.0 to 1.5 pounds active ingredient per acre in flood irrigated fields.

Time of Application: Apply in the spring before dodder germinates. On *furrow or rill irrigated* fields, a shallow incorporation should be followed by irrigation within 7 days. On *sprinkler irrigated* fields, lower rates can be used if followed immediately by irrigation. Do not delay irrigation more than 7 days or use sets of longer than 12 hours. On *flood irrigated* fields, application should be followed by flooding within 1 to 3 days.

Remarks: Seldom is 100% dodder control obtained by field treatment. Growers should patrol fields in search of dodder patches, which should be spot treated.

Chemical: dichlobenil.—Seed alfalfa only.

Rate of Chemical: For control of all species of dodder and certain grassy and broadleaf annual and perennial weeds, apply 4% granules at 35 to 50 pounds per acre, one or two times during the season. Do not exceed 100 pounds of product during one growing season.

Time of Application:
First Crop Seed—Where hay is not harvested before producing the seed crop, apply 4% granules in early spring to a smooth soil surface *before* irrigation, or incorporate very lightly immediately following application. Severe incorporation will cause stunting of growth and some foliage symptoms may occur. Cross incorporation with a fine-tooth harrow is recommended if mechanical incorporation is necessary. To insure continued control of dodder, make a second application of 35 to 50 pounds of 4% granules three to five weeks after the first application and follow with furrow or sprinkler irrigation.

Second Crop Seed—For best results, where a hay crop is harvested before producing the seed crop, remove the forage as soon as possible and destroy any stubble-attached dodder by flaming or mechanical cultivation. This should leave the field in a dry-tilled condition. Then recorrugate if furrow irrigation is used. Allow alfalfa to become re-established and grow to approximately 4 to 6 inches tall and make an application of 4% granules at 35 to 50 pounds per acre followed by irrigation.

Cautions: Treated alfalfa fields should not be grazed nor should forage from treated fields be fed to livestock.

CRIMSON AND SUBTERRANEAN CLOVERS

- **Problem:** ***The Control of Weedy Annual Grasses and Volunteer Cereals in Western Oregon***

Chemical: propham

Spray Mixture: Use 4 pounds per acre in 10 to 20 gallons of water.

Time of Application: Application should be made in the fall after the clover has at least 3 to 4 true leaves. December applications are preferred over earlier applications.

Chemical: pronamide

Spray mixture: Use 0.75 to 1.5 pound active ingredient (1.5 to 3.0 pounds of 50% wettable powder) in 20 to 50 gallons of water per acre. Use the higher rates for well established grasses or small grains.

Time of Application: Applications should be made after the clover has 3 to 4 trifoliate leaves. December applications are preferred over earlier applications.

Cautions: Do not graze treated field or harvest for forage within 120 days of treatment. If the legume crop treated with pronamide is winter killed or otherwise destroyed, do not plant the field in the spring to small grain or grass crop since these crops may be injured from residual pronamide in the soil.

Pronamide does not control winter annual broadleaf weeds such as groundsel, hawksbeard, mayweed, etc. (composite family).

Problem: ***The Control of Perennial Grasses, Such As Quackgrass, Creeping Velvetgrass, Bentgrass, In Field Cleaning***

Chemical: EPTC

Spray Mixture: Use 3 pounds per acre of EPTC in 20 or more gallons of water.

Time of Application: Field should be thoroughly cultivated prior to treatment to chop up and incorporate plant residues, roots, rhizomes, etc. Application should be made on the seedbed prior to the final discing and harrowing. Application should be made to soil dry enough to permit thorough mixing by discing two directions to a depth of 4 to 6 inches immediately after spraying. Seeding of the clovers may be done any time after treatments have been worked into the soil.

Remarks: EPTC is of special value in controlling perennial grasses.

Cautions: There are no particular precautions in the use of this material other than to avoid contact with clothing since the material has a very disagreeable odor which cannot easily be washing from clothing. EPTC treatment may cause some stunting and leaf malformation of the clover during the first few weeks after emergence. This injury is temporary and rapidly outgrown.

Appendix G

GRASS SEED PESTS

The symbol * is used to identify legal pesticide uses not found on pesticide labels. These pesticide uses are not recommended by University of Idaho personnel.

Pest	Description and damage	Control Amount of active ingredient per acre	Remarks Interval between last application and harvest
Aphids Rose-grass aphid Acyrthosiphon dirhodum English grain aphid Macrosiphum avenae Oat birdcherry aphid Rhopalosiphum padi	Aphids feed by sucking plant juices and damage developing seed, which results in light weight and reduced yield. Bluegrass is most susceptible to damage. Treat if colonies are forming before heading.	malathion - 1 lb. parathion - 0.4 lb. diazinon - 0.5 lb.	No time limitation. 15 days. 21 days. **WARNING:** Do not allow sprays to contaminate blooming weeds because of hazard to bees.
Banks grass mite Oligonychus pratensis **Brown wheat mite** Petrobia latens	Not a true insect. Mites feed by sucking juices from the leaves, which produces white "stippled" areas on leaves, and reduces seed yield.	sulfur - 25 lbs. dust parathion - 0.8 lb. - 0.5 lb. dust	No time limitation. 15 days.
Billbug Sphenophorus venatus confluens and possibly others	Large, dark snout weevil. Legless, grub-like, dirty-white, larvae feed on the roots and crown of grass plants. Has caused severe damage to stands of orchard grass and occasionally to established bluegrass. Adults become active beginning in late March and infestations should be evident in April.	diazinon - 3 lbs. granules Apply in mid-April avoiding periods of heavy rainfall. (Oregon registrations only) fensulfothion 15G - 4 lbs. (Dasanit) Oregon state label	Do not apply with fertilizer. Broadcast in mid to late April when adult billbugs are active. Do not feed or forage grass, straw, or seed cleanings. Do not use straw for livestock bedding.
Cutworms Crown Feeders most common are: Glassy cutworm Crymodes devastator in Willamette Valley Protagrotis obscura in Eastern Oregon, Washington, Idaho	Cutworms damage the plant by feeding on the crowns and leaves of the developing plants. Damage frequently occurs in fall and may continue through winter and into spring months. Pheromone traps baited with the cranberry girdler pheromone can be used to sample populations of Protagrotis obscura.	Dyfonate - 4 lbs. Dursban - 1 lb. Warning: Heavy carbon residue from field burning prevents penetration. Irrigation or rain immediately after application greatly improves results.	Do not feed. Do not feed.
Grass gelechiid Chiconodes psiloptera in Eastern Oregon, Washington, Idaho	Larvae feed on the plant crowns. Damage first appears as individual dead tillers progressing to destination of the plant during August-November.	Same as for cutworms.	Same as for cutworms.
Grasshoppers Chorthippus longicornis Clearwinged grasshopper Camnula pellucida Melanoplus spp.	Both young and adults feed on seed heads and destroy the developing seeds. Bentgrass is particularly susceptible to damage. NOTE: Use only malathion, diazinon or Sevin in areas where there is a possibility of pesticide drifting to dairy pastures or forage crops.	diazinon - 0.75-1 lb. Sevin - 1 lb. malathion 0.6 lb. (8 fluid oz.) ULV.	21 days. No time limitation. No time limitation. **WARNING:** Do not allow sprays to contaminate blooming weeds because of hazard to bees.
Leaf miner Phytomyza nigra	Larvae mine galleries in the lower leaves of grasses during the spring and fall in western Oregon. Grass appears to withstand and outgrow the injury.	The larvae are heavily parasitized by insects, and this may aid in keeping this insect in relatively low numbers.	

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GRASS SEED PESTS (continued)

Pest	Description and damage	Control Amount of active ingredient per acre	Remarks Interval between last application and harvest
March fly Bibio xanthopus	Larvae are ½ inch long, 1/16 inch wide and muddy-grey in color. Larvae feed primarily on dead organic matter, but when abundant may cause damage by feeding on roots of seedlings.	No surface-applied insecticide has been effective.	The following cultural practices may help in reducing damage: 1. Prepare a fine seed bed and pack well. 2. Close seed row at planting. 3. Plant early, well-established seedlings. They tolerate feeding injury better than small ones.
Meadow plant bug Primarily the true meadow plant bug, Leptopterna dolobrata, but several other species of plant bugs occur in seed fields.	Meadow plant bug adults are dirty-yellow and dark brown, narrow, about 3/8 inch long, with either short or long wings. They have a rank odor. Suck plant juices and reduce seed yields if abundant. Produce silver top by feeding on stem just above the uppermost node.	Burning destroys the over-wintering eggs in the straw. Where burning is practiced, fields are almost free of the complex of plant bugs. +Diazinon - 0.5 lb.	21 days. Apply prior to heading out when the head is in the boot.
Sawflies In early summer: Dolerus nitens and Pachynematus setator.	Damage is caused by larvae feeding on developing leaves and stems. They resemble caterpillars in general appearance, are about 1 inch long, and light green in color.	malathion - 1 lb.	No time limitation.
"Silver top" Produced by plant bugs. See Meadow Plant Bug.	"Silver top" is a condition in grasses where the inflorescence turns white and, simultaneously, the stem shrinks just above the uppermost node; the seed is sterile. Most effective time for application would be immediately prior to emergence of the main crops of heads: late April or early May.	Insecticides known to be effective in controlling "silver top" are no longer registered. NOTE: "Silver top" is most noticeable in fine-leaf grasses (bluegrasses, bents, and fine fescues).	
Sod webworm (cranberry girdler) Chrysoteuchia topiaria	Larvae feed on plant crowns and can completely destroy the stand. Larval infestations can be reduced by control of adults. Pheromone traps baited with cranberry girdler pheromone (available from: Zoecon Corp., Pherocon Supply Service, 975 California Ave., Palo Alto, CA 94304) can be used to monitor populations. Traps that capture an average of 30 moths per day for 5 consecutive days before June 20 usually result in significant damage to the stand.	Larval Control: Dursban - 1 lb. Dyfonate - 4 lbs.	0 days. Do not feed. Apply by air or ground in late spring using 40 lbs. of 10G per acre in late spring or early summer. Do not feed or graze.
		Diazinon - 1 lb.	21 days if hay or screenings are fed to livestock. 2 days if grass is grazed.
		Adult Control: Diazinon - 1 lb.	See above. Attempts to control larvae with insecticide after harvest have failed. Disease and predation by birds is usually more effective than insecticides. Insecticides may be of value in Eastern Oregon and Washington during August and September when the application is followed immediately with irrigation. Heavy carbon residues from field burning prevent control.
Symphylans Scutigerella immaculata	Small white animals ¼ inch long, 12 to 17 pairs of legs. Live in soil. In new plantings symphylans feed on root hairs and roots. Thin stands in irregular patches.	Dyfonate G or 4E - 2 lbs.	Broadcast and immediately incorporate to a depth of 2 to 3 inches. Activity lost rapidly without soil incorporation. Do not feed.

BEST COPY AVAILABLE

GRASS SEED PESTS (continued)

Pest	Description and damage	Control Amount of active ingredient per acre	Remarks Interval between last application and introduction of bee pollinators
Thrips Several species including: *Aptinothrips rufus* *Aptinothrips stylifera* *Aptinothrips obscurus*	Small, winged or wingless narrow insects about 1/16 inch long. Some species can cause the foliage to turn whitish or rusty colored, and damage developing florets. The seed is sterile. Part or all of the seed head turns white and often is referred to as one type of "silver top." The cause of stunting and browning of grass seed heads is NOT known.	diazinon - 0.5 lb. malathion - 1 lb. Metasystox-R - 1 lb.	21 days No time limitation. Do not pasture or use treated crop for feed, food, forage, or bedding. Labelled for use on bluegrass seed only.
Winter grain mite *Penthaleus major*	Removal of chlorophyll and plant juices from the leaves by feeding mites causes infested fields to have a grayish or silvery appearance. Small grains and grasses are favored hosts but mites may damage legumes and vegetables.	parathion - 0.5 lb. malathion - 1 lb.	15 days. No time limitation.

TABLE BEET SEED PESTS

The symbol * is used to identify legal pesticide uses not found on pesticide labels. These pesticide uses are not recommended by University of Idaho personnel.

Pest	Description and damage	Control Amount of active ingredient per acre	Remarks Interval between last application and harvest
APHIDS Bean aphid (black) *Aphis fabae* Green peach aphid *Myzus persicae*	Plant lice which may colonize on leaves and seed shoots.	Phosdrin - 0.25 lb. parathion - 0.5 lb. malathion - 1 lb. Trithion - 0.5 lb. diazinon - 0.5 lb. methyl parathion - 1 to 1.2 lbs. Monitor - 1 lb.	Especially important to control aphid spread of yellows virus diseases before seed crop development. Wa. 24(c)
Alfalfa looper *Autographa californica*	Adult moth grayish to light brown in color. Mature larvae about 1 inch long, light green to olive green with a pale colored head. Move in looping fashion.	parathion - 0.6 lb. trichlorfon (Dylox)** - 1.5 lbs. Sevin - 1 to 2 lbs. Bacillus thuringiensis	Larger caterpillars are difficult to control—check fields early. See manufacturers' directions.
Armyworm Western yellowstriped armyworm *Spodoptera praefica* Beet armyworm *Spodoptera exigua*	Caterpillars are 1½ to 2 inches long when mature. They are velvety black with 2 prominent, and several fine, bright yellow stripes on the sides. Light color forms also occur.	parathion - 0.6 lb. trichlorfon (Dylox)** - 1.5 lbs.	Larger caterpillars are difficult to control—check fields early.
Cutworms Redbacked cutworm *Euxoa ochrogaster* Other cutworms	Cutworms are usually dull gray, brown or black and may be striped or spotted. They often curl up when disturbed. Cutworms usually feed at night. They cut off young plants or feed on the foliage of older plants.	trichlorfon cutworm baits carbaryl cutworm baits carbaryl (Sevin) - 1 lb. trichlorfon (Dylox)** - 1.5 lbs.	Control erratic when cutworm is in soil—best results usually following irrigation. Keep close check early in season, because mature cutworms are extremely difficult to control. See label directions when using cutworm baits.

**Buffering Dylox to an acid condition has extended the control period in areas where alkaline water conditions exist. Do not use water over 80°F. Hot water inactivates Dylox. Do not use more than 1 to 2 pts. of acidifier per 100 gals. of spary because of increased hazard to honey bees.

BEST COPY AVAILABLE

Appendix H

7

CLEAN CROP®

AMINE 4
2,4-D
Weed Killer

For selective weed control in small grains, corn, sugar cane, pastures, rice, turf and non-crop areas.

ACTIVE INGREDIENTS:	
*Dimethylamine salt of 2,4-Dichloro phenoxyacetic acid	46.5%
INERT INGREDIENTS:	53.5%
	100.0%

*Equivalent to 38.6% 2,4-D acid or 3.8 pounds per gallon
*Isomer specific by AOAC Method No. 6.DO1-5

Keep Out Of Reach Of Children

CAUTION

STATEMENT OF PRACTICAL TREATMENT

In case of contact, flush eyes with plenty of water for at least 15 minutes and get medical attention. Wash skin with plenty of soap and water.

SEE SIDE PANELS
FOR ADDITIONAL PRECAUTIONARY STATEMENTS

® CLEAN CROP is the Reg. TM of Balcom Chemicals, Inc.

NET CONTENTS__________U.S. GALLON(S)
EPA REG. NO. 34704-5

FORMULATED FOR **PLATTE CHEMICAL CO., Inc.**
150 SO. MAIN STREET. FREMONT, NEBRASKA 68025

AgIII-XIII-88

CLEAN
CROP®

MCPA SELECTIVE WEED KILLER

(Sodium Salt of MCPA)

FOR SELECTIVE CONTROL OF CERTAIN WEEDS IN CROPS, GRASSLAND, TURF AND NON-CROP AREAS.

ACTIVE INGREDIENT:	
Sodium salt of	
2 methyl 4 chlorophenoxyacetic acid*	22.25%
INERT INGREDIENTS:	77.75%
TOTAL	100%

*2 methyl 4 chlorophenoxyacetic acid Equivalent [illegible] 1.86 lbs./gal.
*Isomer Specific by A.O.A.C. Method No. 6.A18 [illegible] (13th Edition)

CAUTION: Keep Out Of Reach Of Children

12P00

General Information

GENERAL INFORMATION: Selective Weed Killer is similar in its general behavior to the 2,4-D compounds. However, research to date indicates that Selective Weed Killer is more selective for some crops under certain conditions.

PRODUCT INFORMATION

Sodium Salt of MCPA is a very slow-acting systemic herbicide. This property allows the chemical to translocate into the root system before the tops are killed. Other chemicals do not kill this slow, effective kill without sterilizing the soil.

CLEAN CROP MCPA SELECTIVE WEED KILLER Rate Per Acre: 1½ gals of product in 100 gals. of water and spray spots to the point of run-off when weeds are in the bud to early bloom stage. If regrowth is evident in the fall, repeat treatment.

CLEAN CROP MCPA SELECTIVE WEED KILLER is selective on broadleaf weeds only, and has no effect on cereal grains at the recommended rates.

CLEAN CROP MCPA SELECTIVE WEED KILLER is a very slow-acting systemic herbicide. This property allows the chemical to translocate into the root system before the tops are killed. Other chemicals do not kill this slow, effective kill without sterilizing the soil.

® Clean Crop Reg. T.M. of Balcom Chemicals, Inc.

EPA REGISTRATION NO.
39335-6-34704

NET CONTENTS

MANUFACTURED FOR **PLATTE CHEMICAL CO., Inc.**
150 SO. MAIN STREET, FREMONT, NEBRASKA 68025

906

VELSICOL

Banvel 5G
GRANULES

AgIII-XIII-89

ACTIVE INGREDIENTS:

dicamba (3,6-dichloro-o-anisic acid)	5.0%
Related acids	0.9%
INERT INGREDIENTS:	94.1%
TOTAL	100.0%

NEW BRUSH AND WEED HERBICIDE

CAUTION

KEEP OUT OF THE REACH OF CHILDREN

See Below for Additional Precautionary Statements

E.P.A. Reg. No. 876-103-AA
E.P.A. Est. No. 36716-TN-1

NET CONTENTS:

CAUTION

Avoid contact with skin, eyes and clothing. In case of contact, wash with plenty of water. Do not store near feed or foodstuffs.

STORAGE AND DISPOSAL

1. **Prohibitions:** Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited. Do not reuse empty container.
2. **Pesticide Disposal:** Pesticide or rinsate that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticides or buried in a safe place away from water supplies.
3. **Container Disposal:** If plastic container, triple rinse or equivalent. Dispose of plastic or paper containers in an incinerator or landfill approved for pesticide containers, or bury in a safe place.
4. **General:** Consult Federal, State or local disposal authorities for approved alternative procedures such as limited open burning.

IMPORTANT

Do not apply BANVEL granules under desirable trees or other plants, or areas where the roots might extend or where BANVEL might be washed into the root area. Do not contaminate domestic or irrigation waters. Pasture and rangeland grasses may be grazed or harvested for dairy feed (green or dry) 60 days after treatment. There is no waiting period between treatment and grazing for animals other than dairy animals. Do not graze meat animals in treated fields within 30 days of slaughter. Rates in excess of 8.0 lbs. dicamba acid equivalent per acre for spot treatment in noncropland may temporarily stunt or eliminate the growth of desirable grasses in the treated areas.

NOTICE

Because Velsicol Chemical Corporation has no control over storage, handling and conditions of use, which are of critical importance, Velsicol Chemical Corporation makes no representation or warranty, either express or implied, for results or residues greater than any tolerance which may be established by appropriate governmental agencies due to misuse, improper handling or storage of this material. Nor does Velsicol Chemical Corporation assume any responsibility for injury to persons, crops, animals, soil or property arising out of misuse, improper handling or storage of this material.

DIRECTIONS FOR USE

USE: PASTURE, RANGELAND, AND NONCROPLAND AREAS SUCH AS FENCEROWS, ROADWAYS, WASTELANDS AND SIMILAR AREAS.

WEED/BRUSH	DOSAGE	APPLICATION
Eastern Persimmon	Use 2 level teaspoonsful of BANVEL 5% Granules per inch diameter of the trunk of the plant. (Example: Use 6 teaspoonsful for a tree with a trunk 3 inches in diameter.)	Scatter the granules evenly on the ground within 6 inches of the trunk. Apply BANVEL granules any time after buds start to open and before the leaves and branches stop growing in the summer.
Creosotebush Tarbush	Use 2 heaping tablespoonsful of BANVEL 5% Granules per 4 feet diameter of canopy.	Make application just prior to or in the early part of the rainy season. Scatter the granules uniformly under the canopy of the shrub.
Salt Cedar	Use 100 to 200 pounds of BANVEL 5% Granules per acre (5 to 10 lbs. dicamba acid equivalent).	Make application just prior to or in the early part of the rainy season. Apply BANVEL granules uniformly over the area to be treated.
Canada Thistle Field Bindweed (Morningglory) Russian knapweed Leafy spurge Bur ragweed Skeletonweed Tansy Ragwort	Apply at the rate of 80 to 160 lbs. BANVEL 5% Granules (4 to 8 lbs. dicamba acid equivalent) per acre. For spot treatment apply 0.5 to 1.0 lbs. BANVEL 5% Granules per sq. rod (272 sq. ft.).	For best results, apply BANVEL granules uniformly when plants are actively growing. This would normally be in the spring or fall when plants are putting out new growth.
Bracken fern	Apply at the rate of 120 to 160 lbs. BANVEL 5% Granules (6 to 8 lbs. dicamba acid equivalent) per acre. For spot treatment apply .75 to 1.0 lb. BANVEL 5% Granules per sq. rod (272 sq. ft.).	Apply granules uniformly as a pre-emergence application before emergence of the fronds.
Artichoke thistle	Apply at the rate of 20 to 40 lbs. BANVEL 5% Granules (1 to 2 lbs. dicamba acid equivalent) per acre. For spot treatment apply 2 to 4 oz. BANVEL 5% Granules per sq. rod (272 sq. ft.).	Make uniform application of BANVEL granules when plants are actively growing.

continued on reverse side

VELSICOL CHEMICAL CORPORATION
341 East Ohio Street, Chicago, Illinois 60611

SP 256

Printed in U.S.A.

ULS-1180

AgIII-XIII-90

PRODUCT NUMBER
2070

SPECIMEN LABEL

BUCTRIL®

HERBICIDE

RHÔNE·POULENC

For the control of certain broadleaf weeds in wheat, barley, oats, rye, flax, garlic, newly planted grasses for sod or seed production, and non-crop areas such as industrial sites, vacant lots, roadsides, and railroad rights-of-way.

ACTIVE INGREDIENT	
Octanoic acid ester of bromoxynil: (3,5-dibromo-4-hydroxybenzonitrile)	33.8%
INERT INGREDIENTS	66.2%

[illegible] 23.2% [illegible] pounds of bromoxynil [illegible]

Keep Out of Reach of Children

WARNING

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not give anything by mouth to an unconscious person. Get medical attention.

IF ON SKIN: Wash with plenty of soap and water. Get medical attention if irritation persists.

IF IN EYES: Flush with water for 15 minutes. Get medical attention.

See Side Panel for Additional Precautionary Statements

Manufactured By

RHÔNE·POULENC CHEMICAL COMPANY
AGROCHEMICAL DIVISION
RHÔNE POULENC INC.
Monmouth Junction, N.J. 08852

EPA Reg. No. 359-564
EPA Est. 359-OR-1
NJ-0680

NET CONTENTS
GALLONS
LITERS

DU PONT

KARMEX®

WETTABLE POWDER

Product Labeling

DIRECTIONS FOR USE

E. I. DU PONT DE NEMOURS & CO. (INC.)
BIOCHEMICALS DEPT., WILMINGTON, DEL.
8-70100 8-80 Made in U.S.A. Printed in U.S.A.

ACTIVE INGREDIENT:
Diuron [3-(3,4-dichlorophenyl)-1,1-dimethylurea] 80%
INERT INGREDIENTS 20%
EPA Reg. No. 352-247

KEEP OUT OF REACH OF CHILDREN.
PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS

CAUTION! MAY IRRITATE EYES, NOSE, THROAT, AND SKIN. Avoid breathing dust or spray mist. Avoid contact with skin, eyes, and clothing.

ENVIRONMENTAL HAZARDS

Keep out of lakes, streams, or ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

IMPORTANT—Injury to or loss of desirable trees or other plants may result from failure to observe the following.

Do not apply (except as recommended for crop use), or drain or flush equipment on or near desirable trees or other plants, or on areas where their roots may extend, or in locations where the chemical may be washed or moved into contact with their roots. Do not use on home plantings of trees, shrubs or herbaceous plants, nor on lawns, walks, driveways, tennis courts, or similar areas. Prevent drift of dry powder or spray to desirable plants. Do not contaminate any body of water. Keep from contact with fertilizers, insecticides, fungicides, and seeds.

Thoroughly clean all traces of "Karmex" from application equipment immediately after use. Flush tank, pump, hoses, and boom with several changes of water after removing nozzle tips and screens (clean these parts separately).

GENERAL INFORMATION

Du Pont "Karmex" Weed Killer is a wettable powder to be mixed in water and applied as a spray for selective control of weeds in certain crops and for nonselective weed control on non-cropland areas. It is noncorrosive to equipment, nonflammable and nonvolatile.

"Karmex" may be applied to soil prior to emergence of weeds to control susceptible weed seedlings for an extended period of time, the degree of control and duration of effect will vary with the amount of chemical applied, soil texture, rainfall and other conditions. Soils high in clay or organic matter require higher dosages than soil low in clay or organic matter to obtain equivalent herbicide performance. Moisture is required to activate the chemical; best results occur if rainfall (or sprinkler irrigation) occurs within 2 weeks of application.

"Karmex" may also be used to control emerged weeds. Results vary with rate applied and environmental conditions, best results are obtained on succulent weeds growing under conditions of high humidity and temperatures of 70°F or higher. Addition of a surfactant such as Du Pont Surfactant WK to the spray (where recommended) increases contact effects of "Karmex."

Since the effect of "Karmex" varies with soils, uniformity of application, and environmental conditions, it is suggested that growers limit their first use to small areas. Observe all cautions and limitations on labeling of all products used in mixtures.

NOTICE OF WARRANTY

Du Pont warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for purposes stated on such label only when used in accordance with the directions under normal use conditions. It is impossible to eliminate all risks inherently associated with the use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of Du Pont. In no case shall Du Pont be liable for consequential, special or indirect damages resulting from the use or handling of this product. All such risks shall be assumed by the Buyer. DU PONT MAKES NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS STATED ABOVE.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

Du Pont "Karmex" Weed Killer should be used only in accordance with recommendations on this label, or in separate published Du Pont recommendations available through local dealers.

Du Pont will not be responsible for losses or damages resulting from use of this product in any manner not specifically recommended by Du Pont. User assumes all risk associated with such non-recommended use.

Do not use in Kern County, California.

SELECTIVE USE IN CROPS

PREEMERGENCE USE (Germinating Weeds): "Karmex", at recommended rates, controls annual weeds such as:

Broadleaves			Grasses		
½ to 1 Lb./Acre	1½ to 2 Lbs./Acre	2 to 6 Lbs./Acre	½ to 1 Lb./Acre	1½ to 2 Lbs./Acre	2 to 6 Lbs./Acre
Lambsquarters	Annual groundcherry	Ageratum	Barnyardgrass (watergrass)	Annual bluegrass	Annual lovegrass
Pigweed	Annual morningglory	Annual smartweed	Crabgrass	Annual sweet vernalgrass	Annual ryegrass
Purslane	Chickweed	Annual sowthistle		Foxtail	Kyllinga
Ragweed	Corn spurry	Corn speedwell		Rattail fescue	Orchardgrass
	Dogfennel	Dayflower		Red sprangletop	Peppergrass
	Fiddleneck (amsinckia)	Flora's paintbrush		Velvetgrass	Ricegrass
	Gromwell	Hawksbeard			Sandbur
	Knawel	Horseweed			Seedling johnsongrass
	Pennycress	Kochia			
	Shepherdspurse	Marigold			
	Tansymustard	Mexican clover			
	Wild buckwheat	Pineappleweed			
	Wild lettuce	Pokeweed			
	Wild mustard	Rabbit tobacco			
		Spanishneedles			
		Velvetleaf (buttonweed)			
		Wild radish			

Partial control of the following weeds usually occurs at rates stated.

Broadleaves		Grasses	
1 Lb./Acre	4 Lbs./Acre	4 Lbs./Acre	8 to 10 Lbs./Acre
Annual morningglory	Horsenettle	Quackgrass	Guineagrass
Cocklebur			Maidencane
Prickly sida (teaweed)			Pangolagrass
Sesbania			
Sicklepod			

POSTEMERGENCE USE (Emerged Seedling Weeds): "Karmex" at recommended rates, controls annual weeds such as annual morningglory, barnyardgrass (watergrass), crabgrass, crowfoot, goosegrass, pigweed and purslane. Addition of Surfactant WK to the spray (where recommended) increases contact effects of "Karmex". Best results are obtained on succulent weeds growing under conditions of high humidity and temperatures of 70°F or higher.

EQUIPMENT—SPRAY VOLUMES AND PRESSURES: Use a tractor-mounted fixed boom power sprayer properly calibrated to a constant speed and rate of delivery. Openings in screens should be equal to or larger than 50 mesh. Continuous agitation in the spray tank is required to keep the material in suspension. Agitate by mechanical or hydraulic means; if by-pass or return line is used, it should terminate at bottom of tank to minimize foaming. Avoid overlapping, and shut off spray booms while starting, turning, slowing or stopping, or injury to the crop may result.

For preemergence application, use 25 to 40 gals. per acre and spray pressure of 30 to 40 psi. For postemergence application, use sufficient volume (min. 25 gals. per acre) for thorough coverage of weed foliage; use spray pressure of 20 to 25 psi to keep spray drift to a minimum.

Aerial: For alfalfa, asparagus, barley (winter), cotton (preplant or preemergence only), grass seed crops, pineapple, sugarcane and wheat (winter), application may be made by aircraft (5 to 10 gals. per acre); avoid overlapping of spray swath and avoid application under conditions where excessive drift may occur. Where land is bedded, make application parallel to rows.

BEST COPY AVAILABLE

AgIII-XIII-91

AgIII-XIII-92

NORTRON
E.C.

HERBICIDE

For selective control of weeds in sugarbeets

TYPICAL LABEL

		Percent by Weight
ACTIVE INGREDIENT: Ethofumesate: (2-ethoxy-2, 3-dihydro-3, 3-dimethyl-5-benzofuranyl methanesulfonate*)		19%
INERT INGREDIENTS:		81%
	Total	100%

*Protected by U.S. Patent No. 3,689,507

This product contains 1.5 lb active ingredient per gallon

EPA REGISTRATION NO. 45[illegible]-5

PRECAUCION AL USARIO: Si usted no lee ingles, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

KEEP OUT OF REACH OF CHILDREN

DANGER

CORROSIVE. CAUSES EYE DAMAGE.
WEAR GOGGLES OR FACE SHIELD WHEN HANDLING.

IF SWALLOWED — DRINK PROMPTLY A LARGE QUANTITY OF MILK, EGG WHITES, GELATIN SOLUTION OR IF THESE ARE NOT AVAILABLE, DRINK LARGE QUANTITIES OF WATER. AVOID ALCOHOL. CALL A PHYSICIAN.

IF ON SKIN — FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES.

IF IN EYES — IMMEDIATELY FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. CALL A PHYSICIAN.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

Corrosive. Causes eye damage. Do not get in eyes. Wear goggles or face shield when handling. Harmful if absorbed through skin. Avoid contact with skin.

FIRST AID — In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. For eyes, call a physician. Get medical attention if skin irritation persists. Remove and wash contaminated clothing before reuse.

ENVIRONMENTAL HAZARDS — Do not apply directly to water. Do not apply when weather conditions favor drift from treated area. Do not contaminate water by cleaning of equipment or disposal of wastes.

PHYSICAL OR CHEMICAL HAZARDS — Do not use, pour, spill or store near heat or open flame.

BFC Chemicals, Inc.
4311 Lancaster Pike P.O. Box 2867
Wilmington, DE 19805

*Trademark of FBC Ltd

5-81 947(2)-061DS

AgIII-XIII-93

CLEAN CROP®

ATRAZINE 80W HERBICIDE

FOR WEED CONTROL IN CORN AND SORGHUM

FOR WEED CONTROL IN CERTAIN OTHER CROPS; IN NONCROP AREAS; AND INDUSTRIAL SITES

ACTIVE INGREDIENTS:		80%
Atrazine (2-Chloro-4-ethylamino-6-isopropylamino-s-triazine	76%	
Related Compounds	4%	
INERT INGREDIENTS:		20%
Total:		100%

CAUTION: KEEP OUT OF REACH OF CHILDREN.

HARMFUL IF SWALLOWED. AVOID CONTACT WITH EYES, PROLONGED CONTACT WITH SKIN, INHALATION OF DUST, AND CONTAMINATION OF FOOD AND FEED.

DO NOT CONTAMINATE DOMESTIC OR IRRIGATION WATER SUPPLIES OR LAKES, STREAMS OR PONDS.

DO NOT REUSE EMPTY CONTAINER. DESTROY EMPTY CONTAINER BY PERFORATING OR CRUSHING AND BURYING IN A SAFE PLACE.

manufactured for:
PLATTE CHEMICAL CO.
150 SOUTH MAIN STREET, FREMONT, NEBRASKA 68025

®REGISTERED TRADE MARK BALCOM CHEMICALS, INC.

EPA REG. NO. 2749-150-AA-34704

EPA EST. NO. 10411-TN-01

CLEAN CROP®

MANUFACTURED FOR:
PLATTE CHEMICAL CO.
150 SOUTH MAIN STREET
FREMONT, NEBRASKA 68025

EPA REG NO. 2749-163-34704

EPA EST. NO. 35982-TX-1

AgIII-XIII-94

ACTIVE INGREDIENT:	
SIMAZINE (2-Chloro-4, 6-bis (ethylamino)-s-triazine)	80%
INERT INGREDIENTS:	20%
TOTAL	100%

CAUTION: KEEP OUT OF REACH OF CHILDREN.

HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH THE SKIN. DO NOT GET IN EYES OR ON SKIN. DO NOT BREATHE SPRAY MIST. WASH THOROUGHLY AFTER HANDLING.

IN CASE OF CONTACT, FLUSH WITH PLENTY OF WATER. FOR EYES – GET MEDICAL ATTENTION.

KEEP OUT OF LAKES, STREAMS, OR PONDS. DO NOT APPLY WHEN WEATHER CONDITIONS FAVOR DRIFT FROM AREAS TREATED. DO NOT CONTAMINATE WATER BY CLEANING OF EQUIPMENT, OR DISPOSAL OF WASTES. APPLY THIS PRODUCT ONLY AS SPECIFIED ON THIS LABEL.

KEEP AWAY FROM FOOD AND FEED.

DO NOT REUSE EMPTY CONTAINER. DESTROY EMPTY CONTAINER BY PERFORATING OR CRUSHING AND BURYING IN A SAFE PLACE.

GENERAL INFORMATION

SIMAZINE 80W is a herbicide that should be applied before weeds emerge or following removal of weed growth. It controls a wide variety of annual broadleaf and grass weeds when used at selective rates in agricultural crops and ornamental plantings. When used at higher, non-selective rates in non-crop areas, it also controls many perennial broadleaf and grass weeds.

Since SIMAZINE 80W enters weeds mainly through their roots, rainfall or irrigation is needed to move ti into the root-zone. Very dry soil conditions and lack of rainfall following application may necessitate shallow cultivation.

SIMAZINE 80W controls most annual broadleaf and grass weeds such as:

Amaranths
Annual Bluegrass
Annual Morningglory
Annual Ryegrass
Barnyardgrass (Watergrass)
Brachiaria spp.
Carelessweed
Carpetweed
Common Chickweed
Crabgrass (Digitaria spp.)
Downey Brome (Cheat)
Fireweed

Mustard
Nightshade
Pigweed
Prickley Lettuce
Purslane
Ragweed
Rattail Fescue
Russian Thistle
Shepherdspurse
Shieldcress
Silver Hairgrass
Smartweed

Flora's Paintbrush
Florida Pusley
Foxtails
Goosegrass
Junglerice
Lambsquarters

Spanish Needles
Tansymustard
Wild Oats
Wiregrass
Witchgrass

SIMAZINE 80W is non-corrosive to equipment, non-flammable, and has low electrical conductivity.

Store SIMAZINE 80W in a dry place.

SIMAZINE 80W is a wettable powder formulation to be mixed with water and applied as a spray. Make a slurry by adding SIMAZINE 80W to a small quantity of water. Pour the slurry into the spray tank during or after filling. Sufficient hydraulic (jet) or mechanical agitation should be provided during mixing and application to keep the material in suspension.

EQUIPMENT:

Ground Application: Use conventional spray equipment with 80° fan-type nozzles. Screens in nozzles as well as those in suction and inline strainers, should be no finer than 50 mesh.

Use hydraulic or mechanical agitation during mixing and application to maintain a uniform suspension.

Use a pump with capacity to maintain 35–40 psi at the nozzles. If hydraulic agitaiton is used, the pump should also provide sufficient agitation in the tank to keep the mixture in suspension.

Wash sprayer thoroughly with clean water immediately after use.

Aerial Application: Use aerial application only where specified in the use directions. Screens in nozzles as well as those in suction and inline strainers should be no finer than 50-mesh.

Avoid application under conditions where uniform coverage cannot be obtained or where excessive spray drift may occur.

Avoid application directly to animals or humans. Although it is unnecessary for flagmen or loaders to wear protective clothing or equipment, care should be taken to avoid inhalation of dust or spray mist, or prolonged contact with skin. Flagmen and loaders should wash thoroughly before eating and at the end of each day's operation.

Wash sprayer thoroughly with clean water immediately after use.

MIXING INSTRUCTION

Make a slurry by adding SIMAZINE 80W to a small amount of water in a separate container. Then pour the slurry into the spray tank partially filled with clean water, and add the rest of the water.

For ground application where the amount of water is not specified, apply SIMAZINE 80W in 20 – 40 gals. of water per acre.

For Aerial application, use a minimum of one gal. of water for each 1 – 1½ lbs. of wettable powder per acre, unless specified differently. For Aerial application, use a minimum of one gal. of water for each 1 – 1½ lbs. of wettable powder applied per acre, unless specified differently.

BAND TREATMENT

The amount of SIMAZINE 80W needed for band treatment may be calculated by the formula:

$$\frac{\text{band width in inches}}{\text{row width in inches}} \times \begin{matrix}\text{broadcast}\\ \text{rate}\\ \text{per acre}\end{matrix} = \begin{matrix}\text{amount}\\ \text{needed}\\ \text{per acre}\end{matrix}$$

NET WEIGHT 50 LBS.

SIMAZINE 80W HERBICIDE

913

914

AgIII-XIII-95

RESTRICTED USE PESTICIDE

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification

POISON

POISON

DO NOT POUR FROM ORIGINAL CONTAINER EXCEPT FOR IMMEDIATE USE. ONE SWALLOW CAN KILL!

SUPPLEMENTAL PAMPHLET

DIRECTIONS FOR USE.
READ WORKER SAFETY RULES
ON BACK PANEL

TO PREVENT ACCIDENTS, NEVER PUT INTO FOOD, DRINK OR OTHER CONTAINERS.

Chevron

ORTHO PARAQUAT CL

DO NOT USE OR STORE IN OR AROUND THE HOME
KEEP OUT OF REACH OF CHILDREN

A Weed and Grass Killer · Harvest Aid Chemical.

	By Wt.
Active Ingredient	
Paraquat dichloride (1,1'-dimethyl-4,4'-bipyridinium dichloride)	29.1%
Inert Ingredients	70.9%

Contains 2 lbs. Paraquat cation per gallon

POISON

DANGER
CAN KILL IF SWALLOWED
HARMFUL TO THE EYES AND SKIN

FIRST AID TREATMENT

IF SWALLOWED

Immediately induce vomiting by inserting finger in throat. Administer fluids and induce further vomiting. Get to a hospital or physician fast.

PROMPT TREATMENT IS ESSENTIAL. Symptoms of injury may be delayed.

SKIN CONTAMINATION

In case of contact, wash immediately with water. Remove clothing and wash skin where necessary. Prolonged contact will cause severe irritation. Repeated contact may increase danger of absorption.

EYE CONTAMINATION

In case of contact, wash thoroughly with water and get medical attention.

INHALATION

DO NOT BREATHE SPRAY MIST

Exposure to spray mist may cause irritation and nose bleeds. Stop and check spray procedure.

Note to Physicians Emergency Information - call (415) 233 3737

WASH AND DESTROY CONTAINER WHEN EMPTY. NEVER REUSE.

Roun

Herbicide by

Complete Directions for Use

EPA Reg. No. 524-308-AA

For use of this product in California see page 78.

AVOID CONTACT WITH FOLIAGE, GREEN STEMS, OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, SINCE SEVERE INJURY OR DESTRUCTION MAY RESULT.

1981-1 897.10-001.30/53

Read each of these sections of this label for essential product performance information.

USE THESE CONVENIENT SECTION MARKERS.

GRAPES	TREE CROPS	MINIMUM TILLAGE	CROPPING SYSTEMS	NON CROP USES	WEED CONTROLLED	MIXING APPLICATION TECHNIQUES SOILS	GENERAL INFORMATION

APPLICATION EQUIPMENT AND TECHNIQUES	15 thru 26
AERIAL EQUIPMENT	15, 16
BOOM EQUIPMENT	17
HAND HELD & HIGH VOLUME EQUIPMENT	17, 18
SELECTIVE EQUIPMENT	18 thru 26
ATTENTION — AVOID DRIFT	11
CROPPING SYSTEMS	46 thru 71
ALFALFA	47, 48
ASPARAGUS	48, 50
BARLEY	47, 48
BEANS, Edible (All)	47, 48
COTTON	47, 48
CORN (All)	47, 48
FALLOW & REDUCED TILLAGE SYSTEMS	50, 51
Weed Control	54, 55
OATS	47, 48
PEAS, English or Green	47, 48
SELECTIVE EQUIPMENT	48
SORGHUM (Milo)	47, 48
SOYBEANS	47, 48
SPOT TREATMENT	48
SUGARCANE	56, 57
TANK MIXTURES	
Emerged Annual Weeds	5[illegible] 53, 54
Emerged Perennial Weeds	54, 55
WHEAT	47, 48
DIRECTIONS FOR USE	37 thru 79
ENVIRONMENTAL HAZARDS	8
GENERAL INFORMATION	9, 10, 11, 12
GRAPES	75, 76
INGREDIENTS	8
LIMIT OF WARRANTY & LIABILITY	5, 6
MINIMUM TILLAGE SYSTEMS	
CORN	57 thru 64
SOYBEANS	65 thru 71
MIXING AND APPLICATION INSTRUCTIONS	12 thru 26
NON-CROP USES	37 thru 46
FARMSTEAD WEED CONTROL	39
INDUSTRIAL, RECREATIONAL & PUBLIC AREAS	38, 39
ORNAMENTALS	39, 40
SILVICULTURAL SITES and RIGHTS-OF-WAY	40 thru 44
TURF GRASSES & GRASSES FOR SEED PRODUCTION	44, 45, 46
PRECAUTIONARY STATEMENTS	7
SOIL TEXTURE	14
STORAGE AND DISPOSAL	8
TANK MIXTURES	13, 14, 52 thru 55
TREE CROPS	72 thru 74
APPLES	74
AVOCADO	73, 74
CHERRY (Non-Bearing)	74
CITRUS — Grapefruit, Lemon, Lime, Orange, Tangelo, Tangerine	73, 74
KUMQUAT	73, 74
NUTS — Almond, Filbert, Macadamia, Pecan, Pistachio, Walnut	74
PEARS	74
WEEDS CONTROLLED	
ANNUAL	26, 27
PERENNIAL	28 thru 32
WOODY BRUSH AND TREES	33 thru 37

Read the entire label.

Use only according to label instructions.

Read "LIMIT OF WARRANTY AND LIABILITY" before buying or using. If terms are not acceptable, return at once unopened.

LIMIT OF WARRANTY AND LIABILITY

This company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this company, including but not limited to incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather (i. weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied with the cormal range being determined on the basis of the average range for the prior 40 years computed from the best available information, and ii. weather perils, including but not limited to hurricanes, tornadoes and floods) as well as weather considerations set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

The buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement.

SPECIMEN LABEL
REDUCED TO 89%

DOW

DOWPON M
GRASS KILLER
Lawn and Garden

THIS ONE REALLY WORKS
MEASURING SCOOP INSIDE

Active ingredients:
Sodium salt of dalapon (2,2-dichloropropionic acid) [illegible]
Magnesium salt of dalapon (2,2-dichloropropionic acid) [illegible]
Inert ingredients [illegible]
Total active ingredients equivalent to 74.0% dalapon (2,2-dichloropropionic acid)
EPA Registration No. 464-473   E P A Est. 464-MI-1

Controls perennial grasses such as Bermudagrass, Johnsongrass, quackgrass and bluegrass; annual grasses such as watergrass, annual bluegrass, and foxtails in Driveways • Flagstone Walks • Around Buildings • Along and under Fences Patios • Tennis Courts • Around Bases of Trees • Edging Walks and Driveways

Can be applied with sprayer, sprinkling can, or hose proportioner

1 POUND

CAUTION: KEEP OUT OF REACH OF CHILDREN
Read Complete Precautions on Side Panel

GENERAL DIRECTIONS – Mixing: When level full the enclosed scoop contains ¾ ounce or 2 level tablespoonfuls of DOWPON M. Fill sprayer or sprinkling can ⅓ full of recommended water, then add recommended amount of DOWPON M. Stir until dissolved, then add remainder of water.

When to Apply: Apply spray when grasses are actively growing but before seed stalks develop. Wet all foliage thoroughly to the point of run-off. Re-spray as necessary.

GENERAL GRASS CONTROL: Over-all Treatment: Use 10 scoops (7½ ounces) of DOWPON M per 1000 square feet. Apply with sprayer or hose proportioner to wet the grass without extensive run-off. **Spot Treatment:** Use 4 scoops (3 ounces) of DOWPON M per gallon of water. Spray to wet grasses, using a pump-up or back-pack sprayer. With a hose proportioner (1 pint or quart capacity container), use 4 scoops of DOWPON M in one pint of water and apply to wet at a 1 to 8 volume ratio. With a sprinkling can, use 2 scoops of DOWPON M per gallon of water and apply to wet the grass. **Do not drench or apply excessively.** Treat grasses close to **established** tree trunks using 2 scoops of DOWPON M per gallon of water. Apply to just wet the grass, using a pump-up sprayer. Do not soak the area. Do not use around small shrubs, newly planted trees, or trees less than 4 years old.

WEED-GRASS CONTROL IN DICHONDRA LAWNS AND IVY (California): Controls Bermudagrass and young stages of annual bluegrass and crabgrass. (1) **Apply to mature dichondra --NEVER on newly seeded or newly transplanted areas.** (2) If lawn has not been fertilized apply fertilizer and thoroughly water 5 to 7 days before applying DOWPON M. (3) Apply in spring and summer when weed grasses are YOUNG and GREEN. (4) Apply to leaf portions of weed grasses in a fine mist spray. Use a minimum of water – just enough to wet foliage as a light rain would do. (5) DO NOT soak the soil. Use a sprayer with an insecticide nozzle to produce a fine mist. **A watering can is unsatisfactory.** (6) **For Spot Spraying:** Use 1 level scoop (¾ ounce) DOWPON M per 6 quarts of spray. Apply as directed in (1) through (5) above. (7) **For Over-all Coverage:** Mix spray solution to evenly distribute no more than 2 ounces to 1000 square feet of turf area. The amount of water used will vary, depending on type of sprayer used – usually one to two gallons of water is sufficient to cover 1000 square feet.

LAWN RENOVATION IN CALIFORNIA AND ARIZONA: Mow dead vegetation if present. Wait two weeks for new grass growth, then spray thoroughly, using ½ pound DOWPON M in 4 gallons of water per 1000 square feet. After 2 to 3 weeks, water at least 15 minutes each day for 1 week. Wait 4-6 weeks to seed, plug or sprig.

USE PRECAUTIONS: To avoid injury to desirable plants, do not allow spray or spray drift containing DOWPON M to contact foliage or roots of such plants, including lawns or other desirable turf. Do not use close to ornamentals or fruit trees other than apple and pear. DOWPON M in the soil may inhibit seed germination and plant growth for 30 days or more, depending on dosage, soil type, temperature and rainfall. Accordingly, on land to be planted to grasses and garden crops, delay planting for at least 30 days.

CAUTION: KEEP OUT OF REACH OF CHILDREN. CAUSES IRRITATION OF EYES. MAY BE HARMFUL IF SWALLOWED. MAY CAUSE SKIN IRRITATION. Avoid contact with Skin, Eyes, or Clothing. In case of contact, flush eyes with water for at least 15 minutes and get medical attention. For skin, remove contaminated clothing and wash skin with plenty of water. Wash clothing before re-use. Rinse empty container with water and discard it.

NOTICE: Seller warrants that the product conforms to its chemical description and is reasonably fit for the purpose stated on the label when used in accordance with directions under normal conditions of use, but neither this warranty nor any other warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE, express or implied, extends to the use of this product contrary to label instructions, or under abnormal conditions, or under conditions not reasonably foreseeable to seller, and buyer assumes the risk of any such use. B977

THE DOW CHEMICAL COMPANY
AND SUBSIDIARIES
MIDLAND, MICHIGAN 48640, USA   HORGEN, SWITZERLAND   HONG KONG
CORAL GABLES, FLORIDA 33134, USA   SARNIA, ONTARIO, CANADA
® Trademark of THE DOW CHEMICAL COMPANY

86-1290 PRINTED IN OCTOBER, 1977.
REPLACES SPECIMEN LABEL 86-1290 PRINTED IN NOVEMBER, 1974.
REVISIONS INCLUDE: (1) CHANGE SIGNAL WORD FROM WARNING TO CAUTION IN COPY.
(2) CHANGE WARNING TO USE PRECAUTIONS.

AgIII-XIII-97

AgIII-XIII-98

UNION CARBIDE

BROMINAL® Broadleaf Herbicide

Controls annual broadleaf weeds in wheat, barley, oats, rye, flax, and newly seeded grasses.
Controls Russian thistle and other annual broadleaf weeds on roadsides, vacant lots, railroads and industrial sites.

WARNING: Keep out of reach of children. See other warnings.

ACTIVE INGREDIENT:
Octanoic acid ester of bromoxynil*
(3,5-dibromo-4-hydroxybenzonitrile) 31.7%

INERT INGREDIENTS: 68.3%
***bromoxynil equivalent 21.8% by weight or 2 pounds per gallon.**

DIRECTIONS FOR CROP USE—WHEAT, BARLEY, OATS, RYE

Apply 1 to 2 pints of BROMINAL broadleaf herbicide per acre after small grains emerge, but before weeds are past the 3- to 4-leaf stage. Weeds that form rosettes should be treated when these weeds are less than 1½ inches across.

Proper timing, rate of application, and spray volume will vary according to the weed species present. See the table below.

Good coverage is essential for maximum weed control. Use 10 or more gallons of water per acre with ground sprayers. Nozzle pressure should be at least 30 psi. Use 2 or more gallons of water per acre with aerial sprayers according to table below. Width of swath must not exceed length of spray boom.

Do not apply to small grains during or after the boot stage. Do not apply when crop is under stress for lack of moisture or when crop forms a canopy over weeds.

BROMINAL broadleaf herbicide may be applied in liquid fertilizer or combinations of liquid fertilizer and water. Use constant agitation until the spray mixture has been completely applied.

Tank mixes permit choosing a herbicide combination most effective for the weed problems present on your farm. Use BROMINAL broadleaf herbicide alone or in combination according to the table below. If the amine of 2,4-D or MCPA* is added, mix these into the water first, then add BROMINAL. If Banvel is tank mixed with BROMINAL, water should be added to the spray tank first, followed by BROMINAL and Banvel*. Follow all cautions and limitations on the labels of the products you select to mix with BROMINAL.

When using a tank mix of BROMINAL and Avenge* fill the tank with about two thirds of the required water and start agitation. Add the BROMINAL and mix thoroughly and with the agitation still running add the Avenge and the remainder of the required water. Agitate and recycle for at least five minutes before spraying and continue agitation until spraying is completed. Do not apply Avenge tank-mix under stress conditions or if the plants are wet with rain or dew or if rain is predicted within 6 hours.

Do not graze treated fields for 30 days after application. When treating with Banvel do not graze treated areas or harvest for dairy feed prior to crop maturity. When treating with Avenge do not graze treated fields or cut treated forage for silage although grain and straw from treated fields can be fed to livestock.

WHEAT—BARLEY—OATS—RYE—FLAX When to Spray, Amounts to Use

Area & Crop Stage	Chemical Rate/Acre	Size of Weeds	Amount of water needed per Acre
Washington, Oregon, Idaho Fall through early spring application before or after tillering	1½-2 pints BROMINAL	Gromwell, tarweed, fiddleneck, mustard, other broadleaf weeds apply before the 4-leaf stage, before rosettes are 1½" across.	Use 10-20 gal. with ground or 5-10 gal. with air application. Use higher rates and volumes for larger weeds or where weed growth is slow due to dry or cold weather.
Application after tillering and before the forming of joints in the stem	1½-2 pts. BROMINAL + ¼lb. A of 2,4-D or MCPA*	Gromwell, tarweed, fiddleneck, mustard, other broadleaf weeds, apply before weeds are 6 inches high	
Apply when spring wheat is from 3-leaf up to joint stage (also Colorado and Montana)	1-1½ pts. BROMINAL + 1/16-⅛ pt. Banvel	Bachelor's button, mustard, nightshade, Russian thistle, wild buckwheat, lambsquarter, fanweed, dogfennel, cow cockle, apply when weeds are small (early seedling)	Use 10 or more gal. of water per acre for ground application
Fall through early spring application when winter wheat is from 3-leaf to joint stage (also Colorado and Montana)	1-1pts. BROMINAL + ⅛ pt. of Banvel	Kochia, fiddleneck, miners-lettuce, prickly lettuce, jacobsladder, alkanet, burchervil, corn cockle, corn gromwell, cow cockle, dog fennel, fanweed, falsflax*, flixweed, henbit, lambsquarter, catchweed, apply when weeds are small (early seedling) PS No 30	Use 10 or more gal. of water per acre for ground application
MIDWEST fall through early spring applications before or after tillering (not underseeded with legumes)	1-1½ pts. BROMINAL	Wild buckwheat, before 5-leaf stage, cow cockle & fumitory, apply before 4-leaf stage	Use 10 or more gal. with ground, 2 or more gal. with air application
Application after tillering and before the forming of joints in the stem	1-1½ pts. BROMINAL + ¼lb. A of 2,4-D or MCPA*	All weeds including wild buckwheat, cow cockle, fiddleneck, tarweed apply after 4-leaf stage but before 6 inches high	Use 10-20 gal. with ground or 4-10 gal. with air application. Use higher volume on larger weeds
Other Areas fall through early spring applications before or after tillering (not underseeded with legumes)	1-2 pts. BROMINAL	Apply to emerged susceptible weeds in the 2- to 4-leaf stage or when rosettes are less than 1½ inches across	Use 10 to 20 gal. with ground or 5-10 gal. with air application. Use higher volumes for larger weeds or when growing conditions are poor
Application after tillering and before the forming of joints in the stem	1-1½ pts. BROMINAL + ¼lb. A of 2,4-D or MCPA*	All weeds including wild buckwheat, cow cockle, fiddleneck, tarweed, apply after 4-leaf stage but before 6 inches high	Use 10-20 gal. with ground or 4-10 gal. with air application. Use higher volume on larger weeds
Winter type wheat 4-leaf to tillered stage and barley 2- to 7-leaf stage throughout the United States. Spring type wheat Idaho, Oregon, Washington and ERA variety in Minnesota and North Dakota 5- to 6-leaf stage	1½-2 pts. BROMINAL + Avenge at 2½ pts. for 1-10 oats per sq. ft. 3 pts. for 11-25 per sq. ft. and 4 pts. for more than 25 per sq. ft.	Wild oats, fiddleneck, wild buckwheat and other broadleaf weeds apply to wild oats in the 3-5 leaf stage and to emerged susceptible broadleaf weeds in the 2-4 leaf stage or when rosettes are less than 1½ inches across	Use 5-20 gal. with ground or 3-10 gal. with air application. If spray vol. exceeds 10 gal., add 0.6 fluid ounces of a surfactant such as Tergitol NPX for each gal. in excess
Flax spring application	1-2 pts. BROMINAL	Weeds in 2-4 leaf stage	Use 10-20 gal./Acre with ground or 5-10 gal./Acre with air application

2,4-D amine—WEEDAR 64 *2,4-D esters—WEEDONE* LV4 MCPA amine—WEEDAR MCPA CONC. MCPA ester—WEEDONE MCPA ESTER
Banvel is a registered trademark of Velsicol Chemical Corp. Avenge is a registered trademark of American Cyanamid Company

810

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AgIII-XIII-99

Net Contents Gallons/ Liters

Diamond Shamrock

Bravo® 500

Danger—Keep Out Of Reach Of Children.
See side panel for additional precautionary statements

AG-SL 1

Bravo® 500
A Broad-Spectrum Agricultural Fungicide

Read entire label carefully and use only as directed

General Information

BRAVO 500 is an excellent fungicide when used according to label directions for control of a broad spectrum of plant diseases.
BRAVO 500 can be used effectively in dilute or concentrate sprays. Thorough, uniform coverage is essential for disease control.
DO NOT combine **BRAVO 500** in the spray tank with pesticides, surfactants or fertilizers, unless your prior use has shown the combination physically compatible and noninjurious under your conditions of use.
NOTE: Slowly invert container several times to assure uniform mixture.

The required amount of **BRAVO 500** should be added slowly into the spray tank during filling. With concentrate sprays, pre-mix the required amount of **BRAVO 500** in a clean container and add to the spray tank as it is being filled. Keep agitator running when filling spray tank and during spray operations. **DO NOT** use on greenhouse-grown crops.

Directions for use

Dosage rates on this label indicate pints of **BRAVO 500** per acre, unless otherwise stated. Applications should be made in sufficient water to obtain adequate coverage of foliage. Gallonage to be used will vary with crop and amount of plant growth. Spray volume usually will range from 20 to 150 gallons (approximately 80 to 600 liters) per acre for dilute sprays and 5 to 10 gallons (approximately 20 to 40 liters) per acre for concentrate ground sprays and aircraft applications. Both ground and aircraft methods of application are recommended unless specific directions are given for a crop.

Metric Conversion Guide
2⅛ pints equals 1.0 liter
4¼ pints equals 2.0 liters

CROP	DISEASES	RATE PER ACRE	APPLICATION DIRECTIONS
Bean (Snap)	Rust	4¼ pts	Use in sufficient water to obtain adequate coverage. Begin applications during early bloom stage or when disease first threatens and repeat at weekly intervals or as necessary to maintain control. DO NOT apply within 7 days of harvest. DO NOT graze treated areas or feed treated plant parts to livestock.
Cabbage Cauliflower Broccoli, Brussels Sprouts	Alternaria leaf spot (Southeastern States only), Downy mildew	2⅛ pts	Use in sufficient water to obtain adequate coverage. Begin applications after transplants are set in field, or shortly after emergence of field seeded crop, or when conditions favor disease development. Repeat at 7 to 10 day intervals or as necessary to maintain control.
	Ring spot (California only)	2¾ pts	For field seeded brussels sprouts, begin applications at time of early sprout development or when conditions favor disease development. Repeat at 7 to 10 day intervals or as necessary to maintain control.
Carrot	Early blight Late blight	2⅛ to 2¾ pts	Use in sufficient water to obtain adequate coverage. Start applications when disease threatens and repeat at 7 to 10 day intervals or as necessary to maintain control.

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AgIII-XIII-100

Bayleton

50% Wettable Powder fungicide

FOR CONTROL OF CERTAIN DISEASES OF GRASSES GROWN FOR SEED

BAYLETON 50% Wettable Powder is a unique, new fungicide which has the ability to control, as well as prevent, certain important fungus diseases, including rusts on grasses grown for seed. BAYLETON has been proven effective in extensive tests conducted by the Agricultural Chemicals Division of Mobay Chemical Corporation.

BAYLETON 50% Wettable Powder is absorbed rapidly and works systemically from within the plant.

BAYLETON 50% Wettable Powder mixes readily with water to form a suspension that can be used in all conventional hand- and machine-operated sprayers.

- **Provides systemic residual control**
- **Stops development of rust pustules on grasses grown for seed**

BAYLETON is a Reg. TM of the Parent Company of Farbenfabriken Bayer GmbH, Leverkusen.

RECOMMENDED USES	Grasses grown for seed
INGREDIENTS	ACTIVE INGREDIENT: 1-(4-Chlorophenoxy)-3,3-dimethyl-1-(1*H*-1,2,4-triazol-1-yl)-2-butanone .... 50% INERT INGREDIENTS .... 50% 100% U.S. Patent No. 3,912,752 EPA Reg. No. 3125-320
RESTRICTIONS ON WAREHOUSE STORAGE	Protect from rain and moisture. Store in a cool, dry place. Do not store next to herbicides. Do not store near feed or food products.
PACKAGING	5 lb. bag. 6 per case. Shipping weight 36 lbs.

CLEAN CROP®

MALATHION 55 INSECTICIDE

Premium Grade

ACTIVE INGREDIENTS:

MALATHION*	55.21%
AROMATIC PETROLEUM DERIVATIVE	39.79%
INERT INGREDIENTS	5.00%
	100.00%

CONTAINS

CYTHION®

INSECTICIDE

"THE PREMIUM GRADE MALATHION"

TRADEMARK OF AMERICAN CYANAMID COMPANY

REG. TRADEMARK AMERICAN CYANAMID COMPANY

*0,0-dimethyl phosphorodithioate of diethyl mercaptosuccinate.

Contains 5 pounds of Malathion per gallon.

CAUTION

KEEP OUT OF REACH OF CHILDREN

Harmful if swallowed. Avoid breathing of spray mist.

Avoid contact with skin; wash thoroughly after using.

Avoid contamination of feed and foodstuffs.

Do not use treated seed for food, feed or oil purposes.

WARNING! FLAMMABLE

KEEP AWAY FROM HEAT AND OPEN FLAME

KEEP CONTAINER CLOSED

LEAKING PACKAGES SHOULD BE REMOVED TO A SAFE PLACE.

Do not store at temperatures below 0°F.

EPA REG. NO. 34704-3

Net Contents ______________ U.S. Gallon(s)

DIRECTIONS FOR GRAIN, SEED USE

For the protection of stored grains such as wheat, oats, rice, corn, rye, barley, grain sorghum and field or garden seeds, against confused flour beetle, rice weevil, granary weevil, saw-toothed grain borer, and Indian meal moth, apply 1 pint Malathion 55 Premium Grade in 2 to 5 gallons of water per 1000 bu. Apply as the grain is being loaded or turned into final storage.

Field and garden seeds can be protected against the above grain pests with a dosage of ½ pt. of Malathion 55 Premium Grade in 1 to 2½ gallons of water per 500 bu. of seed.

To protect stored grains from attack by Indian meal moth, apply Malathion 55 Premium Grade to the surface of clean or uninfested grain at the rate of ½ pt. in 1 to 2 gallons of water per 1000 sq. ft. of grain surface area. Apply the spray evenly over the surface of the grain. Apply immediately after grain is loaded into storage and repeat if necessary.

For a residual wall, floor, and machinery spray in grain elevators, in treating truck beds, box cars and ships' holds before loading grain, apply 1 gallon of Malathion 55 Premium Grade per 25 gallons of water making thorough application. Before applying spray, clean elevators, box cars, etc. thoroughly. Remove and burn all sweepings and debris.

DIRECTIONS FOR CROP USE

Begin applications when insects first appear and repeat as required. Full coverage is essential for control. Observe days interval between last application and harvest indicated by the number in ( ) following the crop.

When applying this material by aircraft, mix the required amount with sufficient water to provide a minimum of 1 gallon finished spray per acre. Care should be taken that this material is not allowed to drift onto neighboring crop or non-crop areas.

FRUIT: AMOUNTS RECOMMENDED ARE AMOUNTS TO USE PER 100 GALLONS OF WATER. APPLY AT PETAL FALL AND EVERY 10 to 14 DAYS THEREAFTER UNTIL CONTROL IS ACHIEVED.

APPLES (3): Wooly Aphid, Bud Moth, Forbes Scale – use 1 pt. Green Apple Aphid, Rosy Apple Aphid – use 1½ pt. Mealy bug, Spider Mites – use 1 to 2 pts. Codling Moth, Plum Curculio, Red banded Leafroller – use 2 pts. Applications of this material may cause injury on McIntosh and related varieties of apples.

PEARS (1): Spider Mites, Pear Psylla, Mealybugs – use 1 to 2 pts. Codling Moth, Plum Curculio, Fruit Tree Leafroller, Red banded Leafroller – use 2 pts. Applications may cause injury to Bosc pears under certain conditions.

PEACHES (7): Oriental Fruit Moth, Plum Curculio – use 2 pts.

PLUMS (3); PRUNES (3): Mealy Plum Aphid – use 1 pt.

®CLEAN CROP is the Reg. T.M. of Balcom Chemicals, Inc.

AgIII-XIII-101

MANUFACTURED BY **PLATTE CHEMICAL CO., Inc.**
150 SO. MAIN STREET, FREMONT, NEBRASKA 68025

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D·z·n®

Diazinon® 50 W

SAMPLE LABEL

Insecticide

For control of certain insects on fruits, nuts, vegetables, field crops, and ornamentals

④ **Pounds**
Net Weight

Active Ingredient:	
O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	50%
Inert Ingredients:	50%
Total:	100%

EPA Reg. No.
100-460

D·z·n® Diazinon 50W is a wettable powder

Keep Out of Reach of Children.

Warning

See additional precautionary statements on left panel.

See directions for use on panel at right.

CIBA-GEIGY

CGA 130-573A

AgIII-XIII-103
Revised December, 1979
Replaces F-47037

UNION CARBIDE SEVIN® 50-W

Active Ingredient: Carbaryl (1-naphthyl methylcarbamate)	50% by wt.
Inert Ingredients	50% by wt.

E.P.A. Reg. No. 264-314

KEEP OUT OF REACH OF CHILDREN

CAUTION

SPECIMEN

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS:
HARMFUL IF INHALED OR SWALLOWED. Avoid Breathing of Dust. Do Not Take Internally. Avoid Contact with Skin and Eyes.
Wear regular long-sleeved work clothing. Change to clean clothing daily. Wash hands and face before eating. Wash thoroughly after handling.
NOTE TO PHYSICIAN: Carbaryl is a moderate, reversible cholinesterase inhibitor. Atropine is antidotal.
Do Not Use 2-PAM, opiates, or cholinesterase inhibiting drugs.

ENVIRONMENTAL HAZARDS:
Avoid direct application to lakes, streams and ponds. Do not apply when weather conditions favor drift from area treated. Do not contaminate water, food or feed by cleaning equipment or disposal of wastes.
BEE CAUTION: MAY KILL HONEYBEES IN SUBSTANTIAL NUMBERS. This product is Highly Toxic to Bees Exposed to Direct Treatment or Residues on Crops. Protective Information May Be Obtained from Your Cooperative Agricultural Extension Service.
Do Not Use When Value of Bees as Pollinators is More Important than Insect Control. Before Applying, Warn Beekeepers to Locate Hives Beyond Bee Flight Range Until 1 Week After Application or to Take Other Equally Effective Precautions.

WARRANTY

1. The manufacturer warrants (a) that this product conforms to the chemical description on the label; (b) that this product is reasonably fit for the purposes set forth in the directions for use when it is used in accordance with such directions; and (c) that the directions, warnings and other statements on this label are based upon responsible experts' evaluation of reasonable tests of effectiveness, of toxicity to laboratory animals and to plants, and of residues on food crops, and upon reports of field experience. Tests have not been made on all varieties or in all states or under all conditions. THE MANUFACTURER NEITHER MAKES NOR INTENDS, NOR DOES IT AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE, ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, AND IT EXPRESSLY EXCLUDES AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.
2. This warranty does not extend to, and the Buyer shall be solely responsible for, any and all loss or damage which results from the use of this product in any manner which is inconsistent with the label directions, warnings or cautions.
3. BUYER'S EXCLUSIVE REMEDY AND MANUFACTURER'S OR SELLER'S EXCLUSIVE LIABILITY FOR ANY AND ALL CLAIMS, LOSSES, DAMAGES, OR INJURIES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, WHETHER OR NOT BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY IN TORT OR OTHERWISE, SHALL BE LIMITED, AT THE MANUFACTURER'S OPTION, TO REPLACEMENT OF, OR THE REPAYMENT OF THE PURCHASE PRICE FOR, THE QUANTITY OF PRODUCT WITH RESPECT TO WHICH DAMAGES ARE CLAIMED. IN NO EVENT SHALL MANUFACTURER OR SELLER BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT.

UNION CARBIDE AGRICULTURAL PRODUCTS COMPANY, INC.
7825 BAYMEADOWS WAY, JACKSONVILLE, FLORIDA 32216

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AG-80122
UCC-01009D9
Made in U.S.A.

SEVIN is the registered trademark of Union Carbide Corporation for carbaryl insecticide

AgIII-XIII-104

RESTRICTED USE PESTICIDE

For retail sale to and use only by Certified Applicators or persons under their direct supervision and for those uses covered by the Certified Applicator's certification

Dyfonate®

4-EC INSECTICIDE—EMULSIFIABLE LIQUID

Complete Directions For Use, Use Precautions and Recommendations

STAUFFER CHEMICAL COMPANY, Westport, CT 06880

EPA Reg No 476-2134-AA A-8

ACTIVE INGREDIENTS:	
O-ethyl S-phenyl ethylphosphonodithioate*	47 3%
Petroleum hydrocarbon solvent	42 1%
INERT INGREDIENTS:	10 6%
	100 0%

Stauffer CHEMICALS

*DYFONATE (Contains 4 pounds DYFONATE per gallon) EPA Reg No 476-2134-AA

MINIMUM STORAGE TEMPERATURE MINUS 40°F

DO NOT USE, POUR, SPILL OR STORE NEAR HEAT OR OPEN FLAME.

Do not transport or store DYFONATE 4-EC with any food or feed intended for human or animal consumption

READ ALL LABEL DIRECTIONS BEFORE USING

NOTICE—READ CAREFULLY

CONDITIONS OF SALE

Stauffer (and seller) offer(s) this product for sale subject to, and buyer and all users are deemed to have accepted the following conditions of sale and warranty which may only be varied by written agreement of a duly authorized representative of Stauffer

WARRANTY LIMITATION

Stauffer warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes referred to in the directions for use on the label subject to the inherent risks referred to below Stauffer makes no other express warranties THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY and there are no warranties which extend beyond the description on the label hereof

INHERENT RISKS

The directions for use of this product are believed to be reliable and should be followed carefully However, it is impossible to eliminate all risks associated with use Buyer assumes all risks associated with use or application of this product contrary to label instructions or resulting from extraordinary weather conditions

LIMITATION OF LIABILITY

In no case shall Stauffer be liable for special, indirect or consequential damages resulting from the use or handling of this product and no claim of any kind shall be greater in amount than the purchase price of the product in respect of which such damages are claimed

This product is sold only for uses stated on its label No express or implied license is granted to use or sell this product under any patent in any country except as specified Country United States of America

☠ POISON DANGER ☠

Keep out of Reach of Children

DANGER: POISONOUS IF SWALLOWED INHALED OR ABSORBED THROUGH THE SKIN RAPIDLY ABSORBED THROUGH THE SKIN DO NOT GET IN THE EYES, ON SKIN, OR ON CLOTHING DO NOT BREATHE SPRAY MIST

Wear a pesticide respirator jointly approved by the Mining Enforcement and Safety Administration (formerly the U S Bureau of Mines) and by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part II

Wear rubber gloves, protective clothing and goggles

Wash hands, arms and face thoroughly with soap and water after handling and before eating or smoking Routinely shower or bathe after work and wash all clothing with soap and hot water before re-using In case of contact, immediately remove contaminated clothing and wash thoroughly with soap and water

FOR PESTICIDE EMERGENCY

In case of suspected pesticide poisoning of man or animals, call a physician or the nearest hospital, or the nearest Poison Control Center, or call collect day or night

(203) 226-6602
Stauffer Chemical Company
OR
(800) 424-9300
Pesticide Team Safety Network

Poison Symptoms:

DYFONATE 4-EC is a highly toxic cholinesterase inhibitor Symptoms include headache, blurred vision, weakness, nausea, discomfort in the chest, abdominal cramps, vomiting, diarrhea, salivation, sweating and pinpoint pupils

Always call a physician in case of suspected poisoning. Atropine is antidotal.

First Aid: If patient has stopped breathing, *immediately* remove from contaminated area, then start artificial respiration, preferably by mechanical means *If swallowed*—do *NOT* induce vomiting Immediately give large quantities of water or milk, if available If vomiting does occur, give fluids again Never give anything by mouth to an unconscious person Call a physician or the nearest Poison Control Center immediately *If inhaled*—remove patient from contaminated area *For skin*—in case of contact, remove contaminated clothing and immediately wash skin thoroughly with soap and water Avoid abrading the skin *For eyes*—in case of contact, flush immediately with water for at least 15 minutes

Information for physician:

Initial measures include removal of secretions, maintenance of a patent airway and, if necessary, artificial respiration *When cyanosis is relieved*, atropine may be administered in large therapeutic doses, repeated as necessary to the point of tolerance If symptoms warrant further treatment, protopam chloride (pralidoxime chloride, 2-PAM chloride) has shown utility as *adjunctive* therapy Never use morphine Continued absorption of the poison may occur, resulting in a fatal relapse after initial improvement, **very close supervision of the patient is indicated for at least 48 to 72 hours.**

Observe the following use precautions

- ■ Read all directions before using
- ■ Do not apply to any crop, or in any manner not specified on this label
- ■ Do not rotate with carrots
- ■ Not for use or storage in or around the home
- ■ Do not apply or allow to drift to areas occupied by unprotected humans or beneficial animals or onto adjoining food, fiber or pasture crops Do not contaminate food or feed
- ■ This product is toxic to fish, shrimp, crab, birds, and other wildlife Birds feeding on treated areas may be killed Keep out of lakes, streams, ponds, tidal marshes, and estuaries Shrimp and crab may be killed at application rates recommended on this label Do not apply where these are important resources Do not apply where runoff is likely to occur Do not apply where weather conditions favor drift from areas treated Do not contaminate water by cleaning of equipment or disposal of wastes Apply this product only as specified on this label

Insects Controlled

Black Cutworm	(*Agrotis ipsilon*)*
Cabbage Maggot	(*Hylemya brassicae*)
Corn Leaf Aphid	(*Rhopalosiphum maidis*)
Garden Symphylan	(*Scutigerella immaculata*)

*(Suppression only)

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Clean Grass Seed Crops Established with Activated Carbon Bands and Herbicides[1]

WILLIAM O. LEE[2]

Abstract. Activated carbon, applied over the seeded row in a band 2.5 cm wide, protected grasses from herbicides applied preemergence. The carbon rate required to protect the grasses varied with the grass species, the herbicide, and the rate of herbicide application. Most of the herbicides controlled weeds effectively between the rows. The herbicides usually controlled weeds less effectively within the carbon bands. Diuron [3-(3,4-dichlorophenyl) 1,1-dimethylurea] was inactivated most readily by the carbon and showed the greatest safety margin on the crop species. Atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine], simazine [2-chloro-4,6-bis(ethylamino)-s-triazine], and terbacil (3-*tert*-butyl-5-chloro-6-methyluracil) required higher carbon rates for crop protection than diuron and showed a much narrower safety margin on crops. Use of this technique made possible the effective control of weeds during establishment and, subsequently, the production of high quality seed in the first seed crop.

INTRODUCTION

THERE is increasing interest in the use of activated carbon to detoxify residues of herbicides in soils and to modify the phytotoxicity of herbicides to plants. Many herbicides are tightly adsorbed by activated carbon (5). Activated carbon is 10 to 100 times as effective as bentonite clay, muck soils, or ion-exchange resins in adsorbing herbicides (5). Ahrens (1) found that simazine and atrazine residues in soils were adsorbed and detoxified by activated carbon, so that sensitive crops could be grown in rotation with crops that were treated with these herbicides. Several research workers have shown that transplanted crops such as strawberry (*Fragaria* spp.), cabbage (*Brassica oleracea* L.), tomato (*Lycopersicon esculentum* Mill.), and root cuttings of certain ornamental plants can be protected from certain herbicides by dipping the roots in a suspension (or slurry) of activated carbon before planting (2, 3, 9). Crops also have been protected from herbicides by incorporating activated carbon in a band in contaminated soils before planting or applying a band of carbon over planted seeds before a herbicide is applied (4, 6, 7, 8).

Grass weeds and volunteer crop grasses that germinate and become established along with grass grown for seed are difficult or impossible to remove selectively. After the desirable grass becomes well enough established to withstand the application of selective herbicides, the undesirable species are also tolerant. Seeds of the volunteer crop grasses and weeds are often about the same shape, size, and density as the crop seed. Consequently, it is difficult and sometimes impossible to separate them mechanically from the crop after harvest. These contaminants reduce the value and quality of the seed and in extreme cases make it unmarketable. Thus, more effective methods are needed for selective removal of unwanted grasses while both are still in the seedling stage. The objectives of this study were (a) to determine whether a narrow band of activated carbon placed over the seeded row would protect newly seeded grasses from herbicides applied preemergence, (b) to determine the amount of activated carbon required to protect grasses from herbicides, and (c) to evaluate the effect of such a practice on the first seed crop.

MATERIALS AND METHODS

Field experiments were conducted from 1967 to 1970 on a Woodburn silt loam soil at the Hyslop Agronomy Farm, Corvallis, Oregon. In these studies, we investigated the use of activated carbon to protect new plantings of Italian ryegrass (*Lolium multiflorum* Lam. 'Tetrone'), perennial ryegrass (*Lolium perenne* L. 'Linn'), tall fescue (*Festuca arundinacea* Schreb. 'Fawn'), chewings fescue (*Festuca rubra* var. *commutata* Gaud.), orchardgrass (*Dactylis glomerata* L. 'S-143'), Kentucky bluegrass (*Poa pratensis* L. 'Merion'), and colonial bentgrass (*Agrostis tenuis* Sibth. 'Highland') from herbicides applied preemergence.

In these experiments, we mixed finely ground activated carbon (Aqua Nuchar A)[3] with water at a ratio of 60 g/L. The resultant slurry was applied as a spray during planting in a band about 2.5 cm wide, over the row after covering. In all experiments, a small tractor equipped with a spray tank and two planter units mounted on the tool bar was used to seed the crops and to apply the carbon bands. The seeders were equipped with double-disk openers and depth bands that maintained a seedling depth of about 1.3 cm. The carbon was applied directly over the seeded row through drop nozzles that were mounted on the seeder units. These nozzles were 7.6 cm above the soil surface. Teejet[3] nozzles with large orifices, 8006 E to 8010 E, were used without screens at a spraying pressure of 352 to 706 g/sq cm to avoid plugging lines and nozzles. The nozzles were angled to obtain the proper band width. The carbon was kept suspended in the spray tank by a vigorous bypass agitation provided by a large-capacity centrifugal pump. The carbon treatments were replicated three times on plots 4.8 m wide. Each carbon plot included twelve continuous rows of grass, planted

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[3] Mention of a trademark of proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

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30.5 cm apart. Row length varied, depending on the herbicide treatments.

Diuron at 2.24, 2.80, or 3.36 kg/ha; atrazine at 1.40, 1.68, or 2.24 kg/ha; simazine at 1.80, 2.24, or 2.80 kg/ha; or terbacil at 0.84, 1.12, or 1.40 kg/ha were applied in strips 2.4 m wide across the carbon treatments, perpendicular to the seeded rows. Each herbicide treatment was also replicated three times. The herbicides were superimposed on the carbon treatments in such a manner as to give a split-plot design with subunit treatments in strips. Water was used as the carrier at 374 L/ha. Identical experiments were conducted on each species included in the study. The fields were fertilized in accordance with fertilizer recommendations for seed crops. The response of the grass crop and weeds to the herbicides was visually assessed 4 to 8 months after treatment while the seedlings were still small enough to distinguish individual plants. Weed grasses usually present included annual bluegrass (*Poa annua* L.), Italian ryegrass, and rattail fescue (*Festuca myuros* L.). Potential for full seed production was assumed when the grass stands were estimated at 50% or better, and weed competition between the rows was eliminated or reduced as much as 70 percent.

In some experiments, a strip of mature grass 0.76 by 4.8 m was harvested from the center of each sub sub-plot to determine the seed yields.

Experiments 1, 2, and 3. Three identical experiments were begun in the fall of 1967. Experiment 1 was conducted on 'Tetrone' Italian ryegrass, experiment 2 on chewings fescue, and experiment 3 on 'Merion' Kentucky bluegrass. During final preparation of the seedbed on September 27, Italian ryegrass seed was broadcast over the experimental areas at a rate of 112 kg/ha to serve as a contaminating crop species. The crops were planted on September 28. Activated carbon was applied during planting in a band 2.5 cm wide on the soil surface over the row at rates of 0 or 319 kg/ha. Terbacil at 0.84 and 1.12 kg/ha, simazine at 2.24 and 2.80 kg/ha, atrazine at 1.68 and 2.24 kg/ha, and diuron at 2.24 and 3.36 kg/ha were applied preemergence on September 29. These operations were completed on dry soil. During the following week 8.58 cm of rain fell. Percent crop stand and weed control were visually assessed on April 9, 1968.

Experiments 4, 5, and 6. Three identical experiments were begun on October 3, 1969. Experiment 4 was conducted on 'Linn' perennial ryegrass, experiment 5 on 'Merion' Kentucky Bluegrass, and experiment 6 on chewings fescue. Activated carbon was applied in a band over the rows at rates of 0, 168, and 336 kg/ha. Atrazine at 1.68 kg/ha, terbacil at 0.84, 1.12, and 1.40 kg/ha, diuron at 2.24, 2.80, and 3.36 kg/ha, and simazine at 2.24 and 2.80 kg/ha were applied preemergence on October 7, 1968. Within an hour 0.76 cm of rain fell. An additional 10.24 cm of rain were recorded from October 11 to 15.

Percent grass stand and weed control were visually assessed February 25, 1969. Grass samples for seed yields were harvested only from the 'Linn' perennial ryegrass in the summer of 1969. The chewings fescue and 'Merion' bluegrass did not produce seed in 1969 and were clipped throughout the summer with a rotary mower. Seed yields were determined for the 'Merion' Kentucky bluegrass and the chewings fescue in 1970.

Experiments 7 through 12. Six identical experiments were started August 29, 1969, to evaluate the possibility of producing seed crops of suitable quantity and quality the first summer after fall plantings. Experiment 7 was conducted on chewings fescue, experiment 8 on 'Linn' perennial ryegrass, experiment 9 on 'Fawn' tall fescue, experiment 10 on 'S-143' orchardgrass, experiment 11 on 'Highland' Colonial bentgrass, and experiment 12 on 'Merion' Kentucky bluegrass. All grasses were planted August 29. Activated carbon was banded over the rows at 0, 168, and 336 kg/ha. Atrazine at 1.40 kg/ha, diuron at 2.24, 2.80, and 3.36 kg/ha, simazine at 1.80 and 2.24 kg/ha, and terbacil at 0.84 and 1.12 kg/ha were applied preemergence on September 2; and about 2.5 cm of water were applied by sprinkler on September 4. A hot, dry wind followed the irrigation and the soil surface dried rapidly. A second irrigation of about 2.5 cm was applied on September 15. Heavy rains, which totaled 5.1 cm, fell from September 17 to 19.

A record amount of precipitation fell during December 1969 and January 1970 (29.4 and 39.0 cm, compared with a normal of 16.7 and 16.0). As a result the experimental fields were covered with 7.5 to 17.8 cm of water.

Percent grass stands and weed control were visually assessed April 24, 1970. Grass seed yields were determined for the 'Linn' perennial ryegrass and 'Fawn' tall fescue in 1970.

RESULTS

Experiments 1, 2, and 3. When 'Tetrone' Italian ryegrass and chewings fescue (experiments 1 and 2) were planted without activated carbon, terbacil, simazine, atrazine, and diuron at all rates severely reduced or eliminated the grasses. In experiment 3, all simazine, atrazine, and diuron treatments eliminated the 'Merion' Kentucky bluegrass planted without activated carbon. 'Merion' Kentucky bluegrass planted without carbon developed satisfactory stands following treatments with terbacil at 0.84 or 1.12 kg/ha. Where activated carbon was banded over the row at 319 kg/ha, grass stands were satisfactory for all grasses following all herbicide treatments (Table 1).

All herbicide treatments controlled weeds effectively between the rows but weeds were less effectively controlled within the carbon bands (Table 1).

Experiments 4, 5, and 6. When 'Linn' perennial ryegrass (experiment 4), 'Merion' Kentucky bluegrass (experiment 5), or chewings fescue (experiment 6) were planted without activated carbon, all atrazine, diuron, and simazine treatments eliminated the grasses. Terbacil at all rates severely reduced the stand of 'Linn' perennial ryegrass and eliminated chewings fescue, but 'Merion' Kentucky bluegrass stands were satisfactory.

When activated carbon was banded over the rows at 168 kg/ha, satisfactory stands of all grasses developed on plots treated with diuron and on the 'Merion' bluegrass plots treated with terbacil. Atrazine and simazine eliminated all grasses. When activated carbon was applied over the row at 336 kg/ha, all of the grasses developed satisfactory stands after all herbicide treatments (Table 2).

All of the herbicide treatments gave 93 to 100% control of grass weeds between the rows. Weed control data are not shown in the table.

When 'Linn' perennial ryegrass was planted without

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Table 1. Percent stand of 'Tetrone' Italian ryegrass, chewings fescue, and 'Merion' Kentucky bluegrass and control of Italian ryegrass on April 9, 1968 in plots protected from herbicides applied preemergence by banding 319 kg/ha of activated carbon over the row on the soil surface (Experiments 1, 2, and 3).

Herbicide	Rate	Ryegrass		Fescue		Bluegrass		Grass Weed Control Rating	
		No carbon	Carbon applied over row	No carbon	Carbon applied over row	No carbon	Carbon applied over row	Between rows	Within bands
	(kg/ha)	(%)	(%)	(%)	(%)	(%)	(%)	(0-10)[a]	(0-10)[a]
Terbacil	0.84	1	72	3	95	78	92	9	6
Terbacil	1.12	0	58	0	97	52	97	10	7
Simazine	2.24	17	98	0	97	0	53	9	4
Simazine	2.80	9	95	0	82	0	60	9	4
Atrazine	1.68	0	80	0	77	0	65	10	5
Atrazine	2.24	0	70	0	77	0	62	10	7
Diuron	2.24	4	95	0	75	0	58	9	3
Diuron	3.36	0	93	0	77	0	67	10	4
Untreated	0	100	100	95	90	80	85	0	0

[a] Weed control ratings made according to the scale 0 = no visible effect and 10 = all plants killed. Ratings are an average of the three experiments.

Table 2. Percent stand of 'Linn' perennial ryegrass, 'Merion' Kentucky bluegrass, and chewings fescue on February 25, 1969 in plots planted in October, 1968 and protected from herbicides applied preemergence by banding activated carbon at 0, 168, or 336 kg/ha over the row on the soil surface (Experiments 4, 5, and 6).

Herbicide	Rate	Perennial ryegrass Carbon (kg/ha)			Kentucky bluegrass Carbon (kg/ha)			Chewings fescue Carbon (kg/ha)		
		0	168	336	0	168	336	0	168	336
	(kg/ha)	%	%	%	%	%	%	%	%	%
Atrazine	1.68	0	0	83	0	0	90	0	0	67
Terbacil	0.84	4	4	97	77	83	100	0	0	85
Terbacil	1.12	1	1	83	62	60	87	0	0	78
Terbacil	1.4	2	1	57	52	52	100	0	0	53
Diuron	2.24	0	70	100	0	93	98	0	83	88
Diuron	2.80	0	70	98	0	90	97	0	77	90
Diuron	3.36	0	52	98	0	80	98	0	73	87
Simazine	2.24	0	0	87	0	0	80	0	0	82
Simazine	2.80	0	0	75	0	0	90	0	0	60
Untreated	0	100	100	100	100	100	100	100	100	100

Table 3. Seed production (kg/ha) of the first seed crop of 'Linn' perennial ryegrass (1969), 'Merion' Kentucky bluegrass, and chewings fescue (1970) in plots planted in October 1968 and protected from herbicides applied preemergence by banding activated carbon at 0, 168 or 336 kg/ha over the row on the soil surface. (Experiments 4, 5, and 6).

Herbicide[a]	Rate	Perennial ryegrass Carbon (kg/ha)			Kentucky bluegrass Carbon (kg/ha)			Chewings fescue Carbon (kg/ha)		
		0	168	336	0	168	336	0	168	336
	(kg/ha)		(kg/ha)			(kg/ha)			(kg/ha)	
Atrazine	1.68	0	0	1,610	0	0	338	0	0	690
Terbacil	0.84	777	570	1,610	630	490	440	0	0	590
Terbacil	1.12	0	0	1,660	671	640	490	0	0	590
Terbacil	1.40	0	0	1,550	660	650	450	0	0	530
Diuron	2.24	0	1,350	1,490	0	510	440	0	660	780
Diuron	2.80	0	1,430	1,490	0	560	430	0	670	719
Diuron	3.36	0	1,190	1,370	0	540	390	0	640	790
Simazine	2.24	0	0	1,580	0	0	350	0	0	710
Simazine	2.80	0	0	940	0	0	400	0	0	310
Untreated	0	1,590	1,520	1,490	520	450	416	630	600	590
LSD (0.05) among herbicides at the same carbon treatment			316			118			225	

[a] Herbicides shown in the table were applied at the time of planting. In addition, the 'Merion' Kentucky bluegrass and chewings fescue were treated uniformly October 25, 1969 with diuron at 2.9 kg/ha and simazine at 2.8 kg/ha, respectively, for control of weeds that germinated during the fall and winter of 1969 to 1970.

carbon, no seed was produced in 1969, except for small amounts on plots where terbacil was applied at 0.84 kg/ha. The 168 kg/ha rate of carbon protected the ryegrass from all diuron treatments, and seed yields were not significantly different from those of the untreated check at the 2.24 and 2.80 kg/ha rates. When activated carbon was applied at 336 kg/ha, only those plots treated with simazine at 2.8 kg/ha showed yields that were significantly lower than those of the untreated check (Table 3).

'Merion' bluegrass seed yields in 1970 (the first seed crop) were equal to or higher than those of the untreated check for all plots treated with terbacil, regardless of whether or not activated carbon was banded over the row. Atrazine, diuron, and simazine killed the plants and eliminated seed production when carbon was not applied. When carbon was banded over the row at 168 kg/ha, bluegrass seed yields were slightly higher than those of the untreated check for all diuron treatments, but atrazine and simazine eliminated seed production. Bluegrass seed yields were not significantly different from those of the untreated check for any herbicide treatment when carbon was banded over the row at 336 kg/ha (Table 3).

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112

Table 4. Percent stand of six grass species on April 24, 1970 planted with activated carbon banded over the row and treated with herbicides applied preemergence (Experiments 7 through 12).[a]

Herbicide	Rate	'Linn' perennial ryegrass			'Fawn' tall fescue			'S-143' Orchard-grass			Chewings fescue			'Merion' Kentucky bluegrass			'Highland' Colonial bentgrass		
		Carbon (kg/ha)																	
		0	168	336	0	168	336	0	168	336	0	168	336	0	168	336	0	168	336
	(kg/ha)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Atrazine	1.40	0	97	100	1	90	87	0	93	93		93	93	0	83	93	0	55	85
Diuron	2.24	2	100	100	15	80	83	0	80	93	0	100	97	0	90	85	0	75	88
Diuron	2.80	2	100	100	13	97	93	0	83	90	0	100	93	0	90	90	0	78	90
Diuron	3.36	0	93	100	3	83	87	0	85	98	0	93	97	0	90	95	0	80	95
Simazine	1.80	7	100	[illegible]	12	73	73	0	80	85	0	93	93	0	88	80	0	68	85
Simazine	2.24	7	100	100	18	77	80	0	85	95	0	93	97	0	90	95	0	55	80
Terbacil	0.84	0	63	80	0	42	70	0	0	73	0	85	97	0	100	98	0	33	95
Terbacil	1.12	0	38	58	0	15	57	0	0	45	0	40	97	0	90	58	0	1	80
Untreated	0	93	90	90	43	47	47	45	59	50	97	97	97	40	50	50	45	45	45

[a] Grass planted August 29, 1969. Herbicides applied September 2, 1969. Water (2.5 cm) was applied by sprinkler irrigation on September 4 and 15 to germinate the grasses and activate the herbicides.

Table 5. Grass weed control within and between the carbon bands on six grass species planted with activated carbon banded over the row and treated with herbicides applied preemergence (Experiments 7 through 12).

Herbicide	Rate	Control of winter annual grass within the carbon bands 4/24/70[a]						Avg. control of winter annual grass weeds between rows
		'Linn' perennial ryegrass	'Fawn' tall fescue	'S-143' orchard-grass	Chewings fescue	'Merion' Kentucky bluegrass	'Highland' Colonial bentgrass	
	(kg/ha)	(0-10)[a]	(0-10)[a]	(0-10)[a]	(0-10)[a]	(0-10)[a]	(0-10)[a]	(0-10)[a,b]
Atrazine	1.40	9	8	6	6	5	3	10
Diuron	2.24	8	6	4	5	4	4	9
Diuron	2.80	9	7	5	5	5	4	9
Diuron	2.36	8	6	4	6	5	4	9
Simazine	1.80	8	6	4	5	4	3	8
Simazine	2.24	8	7	5	6	4	3	9
Terbacil	0.84	9	9	9	9	9	6	9
Terbacil	1.12	10	10	9	9	10	9	10
Untreated	0	0	0	0	0	0	0	0

[a] 0 = no control, 10 = all plants killed.
[b] Average of observations made in the six species.

No seed was produced in 1970 (the first seed crop) on chewings fescue planted without carbon. When carbon was applied at 168 kg/ha, seed production was equivalent to that on the untreated check only on those plots treated with diuron. When carbon was banded at 336 kg/ha, only simazine applied at 2.8 kg/ha resulted in seed yields significantly lower than those of the untreated check (Table 3).

Experiments 7 through 12. 'Linn' perennial ryegrass (experiment 7), 'Fawn' tall fescue (experiment 8), 'S-143' orchardgrass (experiment 9), chewings fescue (experiment 10), 'Merion' Kentucky bluegrass (experiment 11), and 'Highland' colonial bentgrass (experiment 12) planted without a band of activated carbon were severely injured or eliminated by atrazine, diuron, simazine, and terbacil at all rates of application (Table 4). When activated carbon was banded over the row at 168 kg/ha, terbacil at 1.12 kg/ha prevented the establishment of satisfactory stands of all grasses except 'Merion' Kentucky bluegrass; and at 0.84 kg/ha terbacil prevented the establishment of a satisfactory stand of 'Fawn' tall fescue. Stands of the other grasses were satisfactory following terbacil at 0.84 kg/ha and following all atrazine, diuron, and simazine treatments (Table 4). When activated carbon was banded over the row at 336 kg/ha, a satisfactory stand of all six grasses resulted except for 'Fawn' tall fescue treated with terbacil at 1.12 kg/ha (Table 4).

All herbicide applications controlled weeds well between the rows in experiments 7 through 12. Grass weed control in the carbon bands was usually less than between the rows. Terbacil usually controlled weeds better in the carbon bands than the other herbicides, which may indicate that this herbicide is less tightly adsorbed. Seedling vigor of the crop species also appeared to influence weed control within the carbon bands (Table 5). Experiments on perennial ryegrass and tall fescue, which germinate rapidly and form vigorous seedlings, showed better weed control within the bands than on the other species which are slower to germinate and establish.

A record amount of precipitation occurred during December 1969 and January 1970 (29.4 and 39.0 cm, compared to a normal of 16.7 and 16.0 cm). The experimental fields were continuously covered with 7.5 to 17.8 cm of water for about 5 weeks. The perennial ryegrass and tall fescue, which are normally grown on wet soils, recovered rapidly after the water drained away and produced good seed crops. The 'S-143' orchardgrass, 'Highland' colonial bentgrass, chewings fescue, and 'Merion' bluegrass, which are normally grown on better drained soils, recovered much more slowly and produced little seed. Thus seed yields were determined only from 'Linn' perennial ryegrass and 'Fawn' tall fescue in 1970.

Little or no seed was produced when Linn perennial ryegrass was planted without carbon. When carbon was banded at 168 or 336 kg/ha, all of the herbicide treatments produced yields higher than those on the untreated check, except for plots treated with terbacil at 1.12 kg/ha (Table 6).

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Table 6. Seed production (1970) of 'Linn' perennial ryegrass and 'Fawn' tall fescue planted with activated carbon banded over the row and treated with herbicides applied preemergence. (Experiments 7 and 8).

Herbicide	Rate	Perennial ryegrass Carbon (kg/ha) 0	168	336	Tall fescue Carbon (kg/ha) 0	168	336
	(kg/ha)		(kg/ha)			(kg/ha)	
Atrazine	1.40	0	1,580	1,695	0	1,350	1,340
Diuron	2.24	88	1,470	1,470	440	1,210	1,200
Diuron	2.80	0	1,460	1,600	480	1,420	1,330
Diuron	3.36	0	1,630	1,820	0	1,180	1,050
Simazine	1.80	587	1,700	1,850	560	1,050	1,060
Simazine	2.24	200	1,580	1,740	460	1,200	1,060
Terbacil	0.84	0	1,420	1,540	0	620	1,070
Terbacil	0.12	0	1,060	1,380	0	200	1,060
Untreated	0	1,480	1,270	1,430	520	480	500
LSD (0.05) among herbicides at the same carbon rate			420			360	

When 'Fawn' tall fescue was planted without carbon, plots treated with diuron at 2.24 and 2.80 kg/ha and simazine at 1.68 and 2.24 kg/ha yielded nearly as much seed as the untreated check, even though the stand was drastically reduced by the herbicide treatment. The other herbicide treatments eliminated seed production when no carbon was applied. When activated carbon was applied at 168 kg/ha, plots treated with 1.12 kg/ha of terbacil yielded less than the untreated check. All other herbicide treatments except terbacil at 0.84 yielded significantly more seed than the untreated check. When activated carbon was applied at 336 kg/ha, seed production was at least twice as high for all herbicide treatments as for the untreated check and for some treatments was almost three times as high (Table 6).

In this experiment, the grasses were planted early in the fall and sprinkle-irrigated to hasten establishment. A good seed crop of 'Fawn' tall fescue, as well as 'Linn' perennial ryegrass, was produced the first summer after seeding. Even though the severe flooding experienced in this experiment prevented the production of sizeable amounts of seed of the other species the first summer after planting, we believe that seed production by some other species the first summer after a fall planting is a possibility. Research will be continued to explore this possibility.

DISCUSSION

In these studies, we found that newly planted grasses were protected from herbicides applied preemergence by spraying a band of activated carbon 2.5 cm wide over the row at the time of planting. Grasses planted without the carbon band and treated with the same herbicides were usually severely injured or killed. Kentucky bluegrass was an exception. This species has considerable tolerance to low rates of terbacil, and when this herbicide was applied, a satisfactory stand was sometimes established without the carbon band.

The carbon rate required to protect the crop grasses varied with the herbicide and the rate of application. Diuron was inactivated by all carbon rates. At the 168 kg/ha carbon rate, protection from herbicides other than diuron was erratic. In some experiments the crops were protected, but in others the same herbicide treatments caused severe damage. When carbon was applied at 336 kg/ha, satisfactory stands usually resulted. However, even at this rate, terbacil at a high rate prevented establishment of orchardgrass.

Grass species such as perennial ryegrass and tall fescue germinate rapidly and make vigorous seedling growth. They are strong competitors to weeds within the row. Thus, it was observed that weed control in the row was usually better with these species than with Kentucky bluegrass, orchardgrass, bentgrass, and chewings fescue, which are slower to establish.

Most of the herbicide treatments provided complete or nearly complete control of all weed growth between the carbon bands. As would be expected, some weeds survived within the bands. However, even in the bands, control ranged from 30 to 100% depending on the crop species, carbon rate, herbicide, and rate of application.

With few exceptions, the yield of the first seed crop was as high as or higher than that of the untreated check when carbon was banded at 336 kg/ha. At the 168 kg/ha carbon rate, yields were sometimes reduced by herbicides other than diuron. Thus, it appears that this technique can be used to control weeds during the establishment of grasses without adversely affecting production of the first seed crop, especially with the higher carbon rate.

At the present time, this technique appears to have greatest potential in crops such as Italian and perennial ryegrass and tall fescue, which produce sizable seed crops the first summer after fall plantings. There is no other feasible means for controlling winter-germinating weeds in fall-planted grasses in western Oregon. Even though some weeds survived in the row, the level of infestation was often reduced enough that it would have been feasible to remove the surviving weeds by hand. Thus, it would be possible to produce high-quality seed from such plantings.

LITERATURE CITED

1. AHRENS, J. F. 1965. Detoxification of simazine and atrazine treated soils with activated carbon. Proc. Northeast. Weed Contr. Conf. 19:364–365.
2. AHRENS, J. F. 1965. Improving herbicide selectivity in horticultural crops with activated carbon. Proc. Northeast. Weed Contr. Conf. 19:366–367.
3. AHRENS, J. F. 1967. Improving herbicide selectivity in transplanted crops with root dips of activated carbon. Proc. Northeast. Weed Contr. Conf. 21:64–70.
4. BRENCHLEY, R. G. 1968. Charcoal, a means of protecting crops in Oregon. Proc. West. Weed Contr. Conf. 22:10–11.
5. COFFEY, D. L. and G. F. WARREN. 1969. Inactivation of herbicides by activated carbon and other adsorbents. Weed Sci. 17:16–19.
6. LINSCOTT, D. L. and R. D. HAGIN. 1967. Protecting alfalfa seedlings from triazine with activated charcoal. Weeds 15:304–306.
7. LOCASCIO, S. J. 1967. Effect of activated charcoal on the toxicity of dichlobenil to vegetables. Proc. S. Weed Conf. 20:157–163.
8. RIPPER, W. E. 1956. A new method of selective weed control for related plants, in particular broadleaf weeds in beets. Proc. Brit. Weed Contr. Conf. 3:225–232.
9. SCHUBERT, O. E. 1967. Can activated charcoal protect crops from herbicide injury? Crops and Soils 19(9):10–12.

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Cascade Growers Report

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CHARCOAL BAND PLANTING SUCCESSFUL

By Lee Zellweger
Tangent Plant Manager

Establishing weed-free stands of perennial grass in the Willamette Valley can be tricky, especially in the fall.

Thanks to Dr. W. Orvid Lee, USDA weed scientist at Oregon State University and Cascade Farm Service we are able to overcome some of these problems. Dr. Lee has developed a planting system that allows grass-seed producers to use pre-emergence herbicides to control weeds without injurying the grass seedlings. A one-inch band of activated charcoal in a liquid slurry solution is sprayed over the row while planting. Following the planting, pre-emergence herbicide (Karmex) is applied. The charcoal band allows the grass seed to germinate in the charcoal safety zone.

Cascade Farm Service first offered charcoal planting to the Willamette Valley growers in 1969. Since the first experimental year we have been using the system on 3,000 to 4,000 acres annually. With this program we have been able to produce certified quality turf-type perennial ryegrass the first year.

Dr. Lee has tested the activated charcoal at various rates of from 75 to 300 lbs. per acre, with a wide range of herbicides. DuPont has a label for Karmex with this system. Experience has shown that this product is adsorbed by charcoal more readily than other herbicides and so offers the best safety margin for the perennial ryegrass seedlings.

One of the biggest problems involved by this program is getting the charcoal to mix in the solution properly. The boys at Cascade call if "petrified smoke." To get around this problem, Cascade has developed a mixer at their Tangent and Rickreall locations. We have been combining the charcoal with Cascade 10-34-0 solution and supplying it to the grower ready to apply.

Cascade is now getting its equipment ready for the fall planting season and will have drills and planters available for this fall.

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Supplies of activated charcoal (Aqua-Nu-Char)® are quite short this season due to some changes and revamping of the manufacturing plant. Cascade has a fairly good supply of this activated charcoal in stock, but we would like to encourage all growers to contact their local Cascade fieldman so that we can be sure to take care of their planting needs this fall.

Charcoal prevents herbicide damage

Oregon grass-seed producers are using a band of charcoal to shield seedlings from herbicides

By John Gerstner/Regional Editor

In Oregon, establishing a week-free stand of perennial grass can be tricky. Broad-leaf weeds and undesirable grasses race the slow-emerging seedlings out of the ground. There's risk of seedling damage in using pre-emergence herbicides. And rains rule out cultivation of fall-seeded grasses.

W. Orvid Lee, USDA weed scientist at Oregon State University, now has an answer to some of these planting pitfalls. He has developed a planting system that allows grass-seed producers to use pre-emergence herbicides to control weeds without injuring tiny grass seedlings. A one-inch band of activated charcoal and water is sprayed over the row at planting. The charcoal intercepts and ties up the herbicide broadcast after the charcoal. The grass seed then germinated unharmed in this charcoal safety zone. A few weeds do too, but they can be controlled by hand weeding or later spraying.

Growing trend. The charcoal system of planting has caught on fast with Oregon grass-seed growers. Cascade Farm Service, Albany, Ore., first offered custom charcoal application in 1969. The firm sprayed 80 acres with charcoal the first year; last year it spread charcoal on 3,000 acres. "Most of our customers use charcoal to establish stands of turf-type perennial grasses in the shortest time possible," says Cascade's Dick Hilsenkopf. "With charcoal they can plant turf-type perennial ryegrasses in the fall and get a seed crop the following summer. With spring planting, you have to wait a whole year for a crop." Orvid Lee estimates that more than 6,000 acres of grass were established with charcoal in 1970.

Lee has tested the charcoal at rates ranging from 75 to 300 pounds per actual treated acre with such herbicides as diuron, atrazine, simazine, terbacil, bromacil, propham, and chlorpropham. The herbicides were applied at rates commonly used for pre-emergence weed control. Diuron, registered for use in Oregon grass-seed production, is adsorbed by charcoal more readily than the other herbicides. Using diuron, Lee has developed good grass stands with just 150 pounds of charcoal per acre, although few seedlings survived the other herbicides with this little charcoal protection.

Lee mixes at the rate of a half pound of charcoal per gallon of water. He recommended from 150 to 300 pounds of charcoal per acre, depending on the herbicide. At the 300-pound rate, he has achieved almost 100 percent weed control between the rows and 50 to 80 percent control in the banded area. "If we get the weeds between the rows, that's 90 percent of the battle," he says.

At the 300-pound treatment rate, charcoal in 12-inch row spacings costs about $6.50 per acre, Lee says. (In 12-inch spacings, only 1/12 of the field is actually treated, which amount to 25 pounds of charcoal for each acre in the field.) Although that may sound expensive, many growers feel the added expense is worth it. And, as Lee reminds growers, the cost is spread over the life of the stand...from three to twelve years.

Poor mixer. Probably the hardest part to applying charcoal is getting it mixed properly. "It's horrible stuff to work with," says Cascade's Dick Hilsenkopf. "It takes longer to get it wet and mixed than to apply it." To get around the problem, Cascade premixes the charcoal and keeps it agitating in a big nurse tank in the field.

Make sure the charcoal and herbicide are applied well before a rain, Lee advises. If it rains before the herbicide is applied, the charcoal soaks up soil organic matter and loses some of its ability to adsorb the herbicide. Lee also recommends applying the charcoal with corrosion-resistant centrifugal or diaphragm pumps, because charcoal is very abrasive. He says liquid fertilizer works well as part of the charcoal carrier, because charcoal doesn't tie up fertilizer and vice versa.

"We think charcoal has a lot of possibilities," says Lee. "It's no miracle elixir nor a substitute for good farming. It's another tool to improve your weed-control results if you've done everything else to the best of your ability."

Other crops. So far, charcoal has been used only in grass-seed production, but Lee says he believes it may be useful in other crops. Sugarbeet-seed growers in Oregon are trying the system on fall-planted beets this year. Their present sugarbeet herbicides sometimes give out in winter. "Charcoal will allow them to use a more-persistent, wider-spectrum herbicide," says Lee. A research gropu headed by A. P. Appleby, agronomist at Oregon State, is running charcoal tests with many other crops and herbicides.

There's a possibility that charcoal could also be used to get around herbicide residue troubles when switching crops. The charcoal could deactivate the herbicide residue so it wouldn't harm a following, susceptible crop. Appleby's group has tried the idea on herbicide spills. It works, Appleby says, but the economics and details of the practice still must be worked out.

But perhaps the most important use of charcoal is yet to come. Lee explains: "The prospects for new pesticides are diminishing every day. It now takes from 5 to 10 years and $3 million to $8 million to develop and market a new pesticide. Due to the ecology movement, companies are losing many registrations for pesticides. Many small chemical companies have gone out of ag research because by the time they get a chemical registered, a pressure group will get it banned. Unless the chemical fits into a major crop, many companies just put it bank on the shelf. Charcoal may open up new uses for existing herbicides. All that would be needed is a clearance for a new use."

Oregon State University

Crop Science Report
RESEARCH/EXTENSION

POTENTIAL FOR GROWTH RETARDANTS in GRASS SEED PRODUCTION

D.O. Chilcote, H.W. Youngberg and D. Albeke (1) (2)

Research results over the past two years indicate a good potential for the use of growth retardants (chemical dwarfing agents) to enhance seed yield of perennial grasses. Perennial ryegrasses, tall fescue and fine fescue have all shown positive yield responses from application of two experimental growth retardants at OSU. Growth retardant application increased the per acre seed production of perennial ryegrasses from 50 to over 100% in 1981. The What, how, and when of the use of growth retardants are questions pertinent to potential use in grass seed production.

What are these materials? After studying a number of chemicals, two experimental compounds with some very special characteristics have been identified for use in the research investigations. These compounds are coded PP333 produced by Imperial Chemical Industries in England and EL500 marketed by Eli Lilly and Company. The compounds produce very similar effects on plants. They reduce stem growth with very little effect on reproductive differentiation and development. The compounds are considered desireable for use in grass seed crops because they do not control inflorescence development while providing good general vegetation growth control. These chemicals are still experimental and have not been registered for use.

What have these experimental compounds been able to accomplish insofar as crop growth is concerned? Basically, the growth retardant compounds have allowed us to create semi-dwarf grass plants similar to what breeders and geneticists have accomplished through their breeding programs in development of semi-dwarf stiff strawed varieties of cereal crops. It should be noted, however, that growth retardants

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(2) We would like to acknowledge the valuable assistance of Daryl Ehrensing, Carroll Moon, William Young and Jim Hunter in harvesting, data collection and processing which made completion of this work possible.

EXT/CS 42
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are now used extensively in Europe to dwarf the taller growing wheat varieties to avoid lodging and improve seed yield. Studies with tall fescue in 1980 provided evidence of dramatic reduction in the height of individual culms with little or no effect on numbers of leaves, leaf area or inflorescence size. These compounds through chemical dwarfing have increased yield and, therefore, enhanced efficiency of production.

The use of growth retardants in our forage and turf grasses has an additional rationale for areas of seed production such as the Willamette Valley and other areas of Oregon since we produce seed of crops developed elsewhere for their characteristics of good forage production or good turf quality. Here, we wish to enhance the seed yield of these crops without altering the genetic constitution. There's little opportunity for breeders of forage or turf varieties to examine seed production as a primary objective and the possibility of combining good forage or good turf characteristics with high seed production is remote and would involve extended breeding and testing procedures. There are also excellent forage and turf varieties of our forage and turf species presently available which are not consistently good seed producers. For these reasons, we explored the use of growth retardants to enhance the growth and crop seed yield. A major benefit of reduced stem growth is reduction or elimination of lodging which can seriously reduce seed production.

The important criteria for these compounds is its effect on seed yield. Table 1 shows the seed yield response of tall and fine fescue comparing treated versus untreated experimental plots in 1980.

Table 1

Seed Yield of Tall Fescue and Fine Fescue Comparing Growth Retardant Treated and Untreated Plots in 1980.

		Clean Seed Yield (kg/ha)		
Species	Variety	Treated	Untreated	% Increase
Tall Fescue	Fawn	1299	790	64*
Fine Fescue	Cascade	762	602	27*

Optimum treatment rates (3/4 pound per acre) and stages of differentiation (floret initiation) were selected for comparison. The results show a significant yield response over a good yield for the untreated plots. The crop stand in these tests was about six years of age.

Table 2 shows the results from similar treatments in 1980 and 1981 with three varieties of ryegrass.

Table 2

Seed Yield of Perennial Ryegrass Varieties Comparing Growth Retardant Treated and Untreated Plots in 1980 and 1981.

	Clean Seed Yield (kg/ha)					
	1980		%	1981		%
	Treated	Untreated	Increase	Treated	Untreated	Increase
Pennfine	1382	930	49	2429	1113	118*
Caravelle	-	-	-	1867	1209	54*
Linn	-	-	-	1879	734	156*

In 1980, the growth retardant resulted in a yield increase of 49% in a six year old stand of Pennfine perennial ryegrass. Again untreated plots produced a moderate to good seed yield. In 1981, treatments were applied to new fields of Pennfine, Caravelle, and Linn perennial ryegrass and in this case, very spectacular yield enhancement was observed an average of 109% over the three varieties. It is difficult to assess whether the different results were due to age of stand or to seasonal variation in environment recognizing that lodging in 1981 was more severe than in 1980.

In 1981, experiments were also established in the Willamette Valley and the La Grande area to examine the effects of growth retardants on bluegrass varieties. Table 3 shows the results of some of these experiments.

Table 3

Seed Yield of Bluegrass Comparing Growth Retardant Treated and Untreated Plots in 1981.

		Clean Seed Yield Kg/Ha		
Species	Variety	Treated	Untreated	% Increase
Bluegrass	Bristol	420	446	(6)
	Touchdown	440	406	8
	Victa	560	589	(2)

Yields were not enhanced in these tests. However, the lack of success in bluegrass is felt to be related to excessive application rate and treatment at the wrong stage of development. The sensitivity of bluegrass to retardants is much greater and lower rates need to be evaluated. Since the inflorescence is a panicle, application at later stages of development needs to be examined.

The next question is "how" seed yield is effected. The application of growth retardants at high rates delayed or prevented lodging in ryegrass until near maturity. Delay of lodging, which without treatment occurred quite early in 1981, would be beneficial to seed production. Obviously, light penetration is dramatically reduced in a lodged canopy. Light reception by leaves and inflorescences to provide for seed filling would be greatly reduced. Those panicles beneath the surface layer would receive less light and on only one side. In addition, the process of pollination, the movement of pollen to stigmatic surfaces, would also be more restricted. Preventing lodging would maintain the culms upright so that pollen would be more freely distributed throughout the plant canopy and light interception would certainly favor the processes of seed set and seed filling. The lodging scores for 1980 and 1981 are given in figure 1 and figure 2. As you will note in both years, lodging occurred prior to anthesis with a greater severity of lodging in 1981. The application of growth retardants, particularly at the rates greater than one-half kg/ha gave almost complete control of lodging through the season.

Another "how" factor in seed yield enhancement is the increase in dry matter partitioned to potential yield and to seed set and seed filling activities. Research in 1980, on tall fescue (Table 4) showed an increase in numbers of spikelets per panicle and more seed at harvest in treated plants.

Table 4

Effects of Growth Retardants on Certain Seed Components and Harvest Index in Perennial Ryegrass (Pennfine) and Tall Fescue (Fawn) 1980.

Species	Treatment	Fertile Tiller M^2	Spikelets/ Spike, Panicle	Florets/ Spikelet	Seeds/ Spikelet	Harvest Index %
Ryegrass	Treated	2583*	21	8	1.66	17
	Untreated	1689	20	8	1.35	8
Tall Fescue	Treated	414	41*	8	2.8	-
	Untreated	326	34	8	1.5	-

FIGURE 1

LODGING SCORES - PERENNIAL RYEGRASS 1980

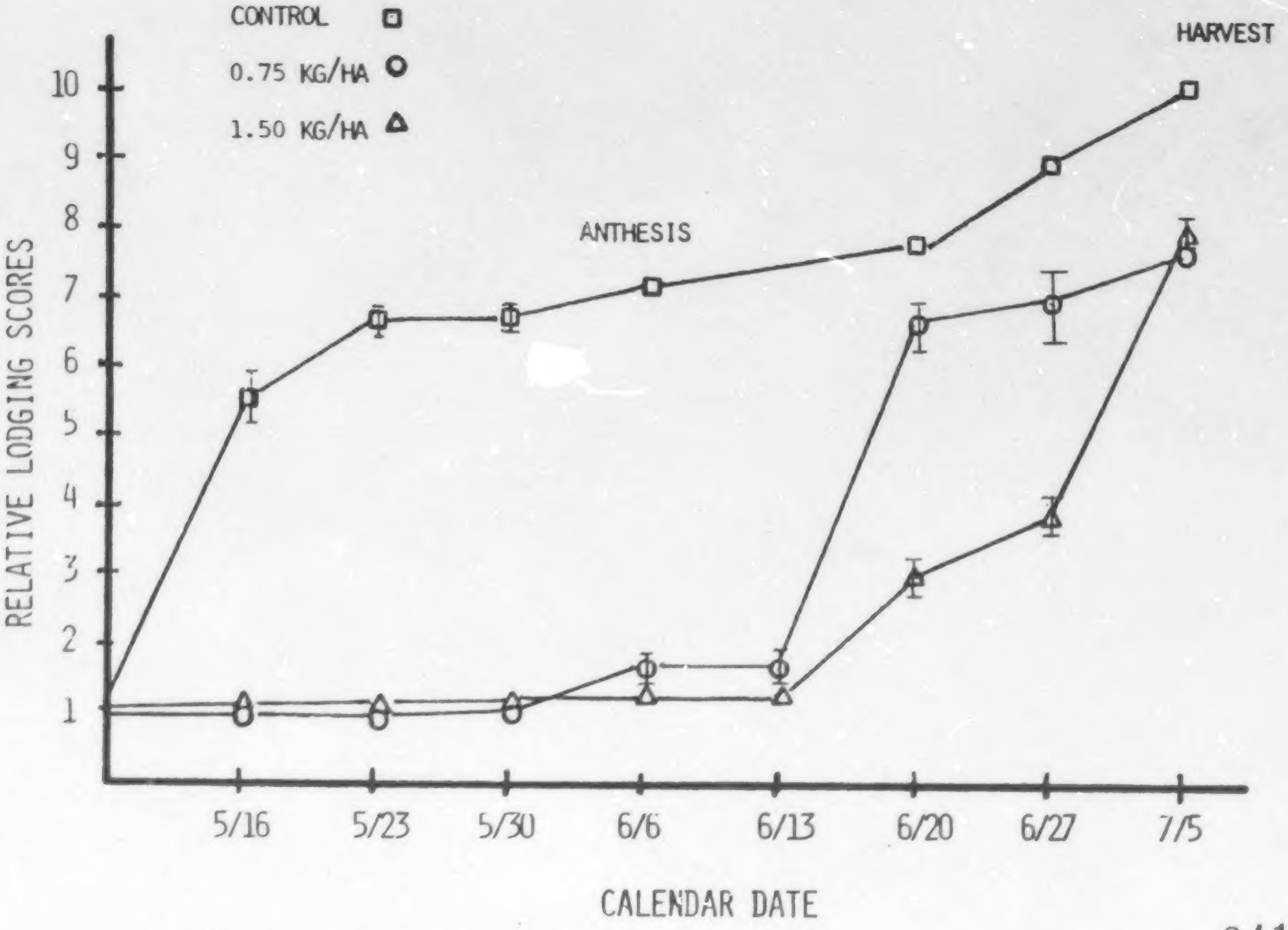

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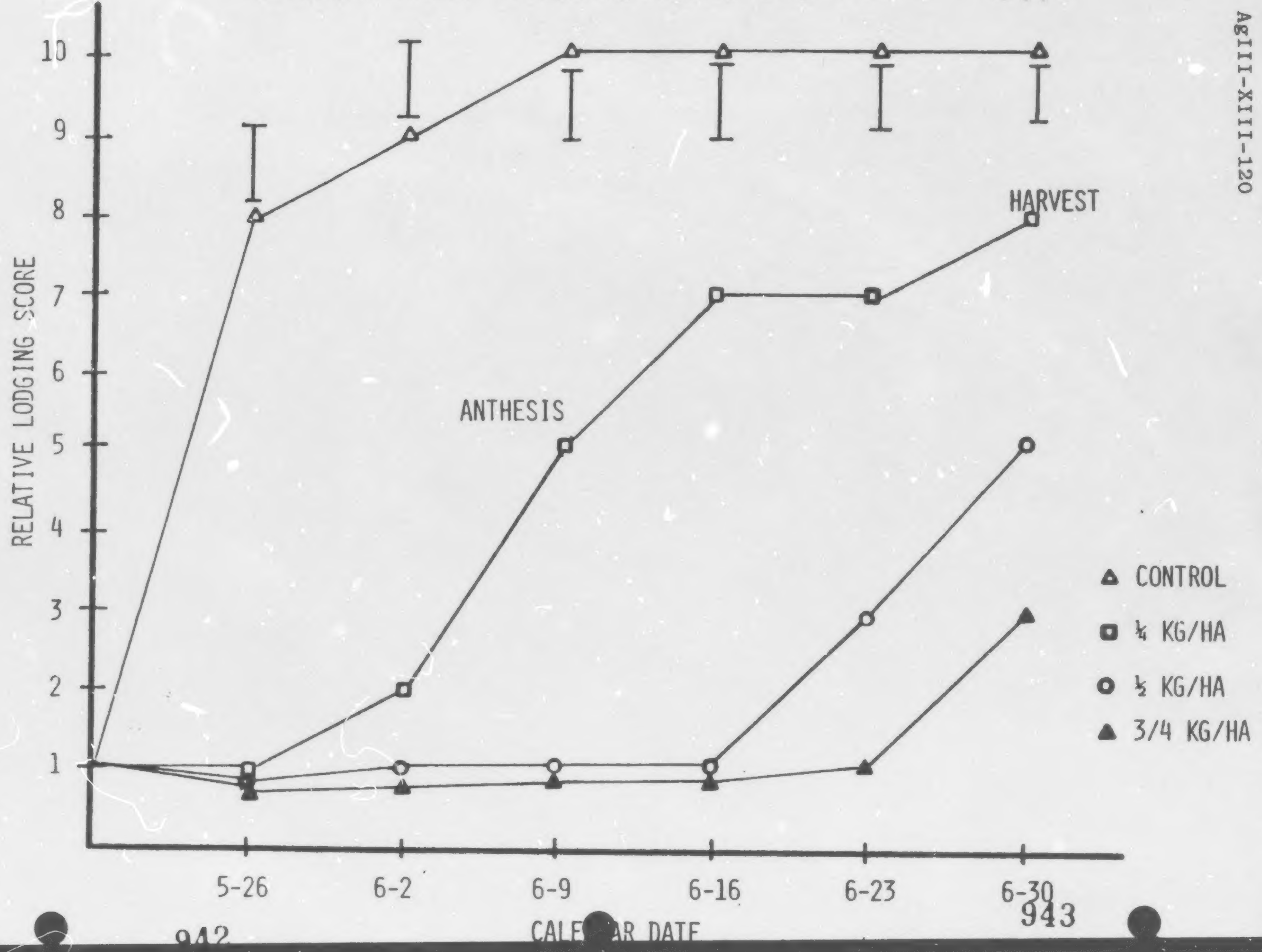
FIGURE 2

LODGING SCORES - PERENNIAL RYEGRASS 1981



In ryegrass, the primary response was an increased number of inflorescences (spikes) and more seeds per spike at harvest time. (Table 4 and 5).

Seed yield in grasses is a product of number of inflorescences per unit area, seeds per inflorescence and weight per seed. The number of seeds per inflorescence is determined by number of spikelets and florets per spikelet and how many of the potential florets mature into a seed. Differences in seed yield can be accounted for by variation in number of inflorescences, or weight per seed or number of seeds per inflorescence. In these tests, yield enhancement by growth retardants was primarily due to increased numbers of inflorescences per unit area and more harvested seeds per inflorescence. The numbers of spikelets and florets per spikelet are not usually different, at least in ryegrass. Since the weight per individual seed is maintained, it appears that the growth retardant by maintaining an upright canopy facilitates light energy capture and improves the seed filling capacity. Usually increased number of seeds is accompanied by reduced seed size. The fact that the weight per seed was not reduced with the dramatic increase in numbers of seeds per unit area is evidence that the seed filling process is enhanced. In other words, of the total number of potential florets, a greater number of those actually produce a seed and this seed is not reduced in weight (size), thus increasing yield.

Harvest index is a ratio of weight of seed harvested divided by the total weight of above ground dry matter produced. Growth retardant treatment improved the percent of dry matter that was harvested as seed versus straw. The result was much more dramatic in 1980 with an older stand than it was for a younger stand in 1981. (See Tables 4 and 5). An improved harvest index may suggest benefits in terms of reduced clean out in the threshing and cleaning processing.

Table 5

Effects of Growth Retardants on Certain Seed Yield Components and Harvest Index in Perennial Ryegrass Varieties 1981.

Species	Treatment	Fertile Tiller M^2	Spikelets/ Spike, Panicle	Florets/ Spikelet	Seeds/ Spikelet	Harvest Index %
Pennfine	Treated	2757*	23	7	2.03*	7*
	Untreated	2064	23	7	.90	5
Caravelle	Treated	2055	20	7	2.4*	8*
	Untreated	1688	20	6	1.63	7

Germination results showed no effect of treatment on this seed quality characteristic.

The results of this work have been very beneficial to our understanding of the restraints to seed yield in grass seed crops. We now know that lodging has a much greater impact on seed yield than we expected. Results provide evidence that we are losing tillers that could potentially become reproductive if we prevent lodging and allow better light penetration and interception. It also appears that seed filling is of major importance to yield and opportunities exist for realizing a greater portion of the seed yield potential.

More research is needed to describe the detailed use of growth retardants in grass seed production. We also need to look at rates of nitrogen fertilizer in conjunction with growth retardant applications. There is obvious potential for use of growth retardants in other species such as alfalfa, sugarbeets and cereals. The potential for growth retardants in seed production appears great and could provide another very beneficial management tool.

The third question of interest is "when" will such compounds be available. At present, indications are that these products will be developed for potential agricultural use. Much remains to be done to establish a basis for registration. 1984 would be the earliest target date for availability for such compounds and, of course, this would depend upon progress made in the development effort. It is likely that these or compounds like them will soon be available to increase our management ability of crop stands for more efficient economic yield.

Conclusions: The results over the past two years with grass seed crops allow us to make the following conclusions: 1) Growth retardants can be used to reduce delay or eliminate lodging; 2) they reduce primarily stem growth and dry matter with little effect on leaf area or number; 3) at proper rates, they do not reduce reproductive development and, in fact, may increase potential yield; and 4) growth retardant applications enhance seed yield primarily by producing more fertile tillers per unit area and providing conditions for better seed filling.

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1982
SEED PRODUCTION RESEARCH
AT OREGON STATE UNIVERSITY USDA-ARS COOPERATING

Introduction

Harold Youngberg

The viability of the seed industry of Oregon is dependent upon its ability to compete in national and international markets. Maintaining a position in this highly competitive situation depends upon the capability to react to problems and to respond to needs. The close working relationship between the seed industry and research staff is essential to deal with problems.

The seed research capability at Oregon State University is not a discrete unit, but is integrated through several departments on the campus. Its success depends upon the cooperative spirit among the research and extension staff. School of Agriculture units involved include the Departments of Agriculture Engineering, Botany and Plant Pathology, Crop Science, Entomology and Soil Science.

Oregon has a strong group of USDA-ARS staff associated with the Departments working closely with state supported colleagues on seed-related problems. This group has supported the seed industry from the beginning of seed production in Oregon.

In addition to research funds from federal and state sources, a major grant from the Oregon Department of Environmental Quality, Field Burning Fund has supported the post-harvest management research and other programs. Grants from firms, commissions, and other sources support several specific projects. The support and advice of the Seed Council Research Committee, the Oregon Seed Trade Association Research Committee and other advisory committees is appreciated.

Information on results of current research work has been made available at the Annual Seed Crop Research Field Day held in late May. Publications relating details of the research and results are prepared at the conclusion of a project. The purpose of this summary is to report the status of work in progress and list the written summaries available to the public.

Contents

Page
Introduction 1
Weed Control in Perennial Grasses Grown for Seed, 1981-82 2
Rate and Time of Spring-Applied Nitrogen on Linn and Pennfine Perennial Ryegrass 2
Seed Yield Enhancement in Grass Seed Crops with Growth Regulators 3
Cereal Seed Yield Enhancement with Growth Regulators 4
Potential Benefits in Grass Seed Production from Combined Use of Growth Retardants and Improved Spring Nitrogen Management . 5
Post-Harvest Management Alternatives for Grass Seed Production 6
  Long-term Effects of Crew Cutting
  Non-yearly Burning
Decomposition of Straw as Affected by Nitrogen Fertilizers and Mechanical Choppers 7
Cooperative Study of *Epichloe typhina* Infection of Tall Fescue Clones and Open-Pollinated Progenies at Corvallis, Oregon and Lexington, Kentucky 7
Grass Variety Seed Yield Evaluation 8
Seed Productivity and Management of Timothy for Seed Production 8
Wheat Variety Identification by Laboratory Methods 8
Cause of Growth Termination in Wheat Seeds .. 9
Establishment of Grass Seed Crops with Cereal Companion Crops 9
Maturation of Subterranean Clover Seed 9
Seed Harvesting and Conditioning Research ... 10
  Seed Scarifier
  Special Indent Separator
  Magnetic Fluid Separation
Research Faculty and Staff 11

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Weed Control in Perennial Grasses Grown for Seed, 1981-82

Orvid Lee, USDA—ARS

Research was continued in western Oregon in 1981-82 on management practices that permit production of a perennial grass seed crop the first summer after early September plantings. The grasses were carbon-planted and irrigated until established. Several herbicides were superimposed on the plantings to control weeds coming in the grass rows. Economic yields were produced the first summer on all perennial grasses except creeping red fescues. Seed yields were as follows: creeping red fescues 300-400 lb/A, bentgrass 600-700 lb/A, Kentucky bluegrass 600-700 lb/A, orchardgrass 800-900 lb/A, and tall fescue 800-1100 lb/A.

Nortron continued to give excellent control of annual bluegrass and other susceptible grass weeds in the carbon bands when applied in early November at rates from 0.5 to 1.0 lb/A. The use of Nortron on fall carbon-planted tall fescue was recently added to the Nortron label and was used on some commercial plantings this fall. Nortron also looks very promising in September-planted orchardgrass and Kentucky bluegrass but has not been added to the label yet. Barban, which looked promising for selective control of annual ryegrass in fall-planted perennial grasses in 1979, 1980, and 1981 experiments, injured all grasses except Kentucky bluegrass in 1982. Thus, more needs to be known about this herbicide before it can be recommended for use.

Sethoxydim (Poast) showed considerable promise for selective control of several hard-to-kill grass weeds in creeping red, chewings, and hard fescues. No visible effects were noted on any fescue plants when sethoxydim was applied at rates to 1.5 lb/A at any stage of growth from 2 leaves through well established plants. Grasses that were sensitive included downy brome, annual ryegrass, perennial ryegrass, bentgrass, Kentucky bluegrass, Canada bluegrass, orchardgrass, tall fescue, sweet vernalgrass, and creeping velvetgrass. Weed grasses that were tolerant included annual bluegrass and rattail fescue. In western Oregon, applications from November through February were more effective in controlling grasses than were applications made later in the spring when the grasses were actively growing. Applications made from November through mid-March did not adversely affect seed production at any rate of application.

Rate and Time of Spring-Applied Nitrogen on Linn and Pennfine Perennial Ryegrass

W.C. Young, H.W. Youngberg and D.O. Chilcote

Nitrogen is the most critical element affecting seed production. Varying the nitrogen rate and time is known to alter the tillering pattern and influence seed yield. Current recommendations for perennial ryegrass suggest 90-112 kg/ha[1] of spring-applied nitrogen split with 50% in March and 50% in April. Crucial to this study is the time of spring-applied nitrogen in relation to morphological stages of crop growth and development.

The primary objective is to determine how spring nitrogen management influences the total number of tillers which produce seed heads. Also, the number of new spring tillers formed and how these tillers influence the final seed yield is important in improving nitrogen efficiency. Early nitrogen treatments were timed before the onset of reproductive development (during vegetative growth) and compared with a later application date following the transition to reproductive development.

The total tiller number of Pennfine perennial ryegrass at anthesis increases with increased nitrogen rate; however, the stand is comprised of a higher percentage of vegetative tillers where nitrogen has been applied early. Split applications appear to increase the number of reproductive tillers at anthesis. The ratio of fertile tillers at maturity to the number at anthesis provides an index of tiller survival. Stimulating the development of numerous spring tillers may increase lodging and cause competition among the developing reproductive tillers which result in tiller mortality. Nitrogen applied early resulted in a greater percentage of tiller survival, whereas nitrogen applied applied after reproductive development has begun increased tiller mortality. A split application of 60 kg/ha + 60 kg/ha was equal to nitrogen applied vegetatively; however, split applications totaling rates greater than 120 kg/ha caused a decrease in tiller survival.

Additional yield component data has shown an increase in spikelets per spike when nitrogen is aplied early, while florets per spikelets were seen to increase as higher total rates were applied. Seed yield was not dramatically affected by the rates or time of application in this study due to yield component compensation. However, improved efficiencies in seed production may result from splitting the spring application.

Nitrogen applied during vegetative growth of Linn perennial ryegrass reduced tiller survival. This suggests that spring-formed tillers cannot contribute to final seed yield as they do in Pennfine perennial ryegrass. Furthermore, the highest percent tiller survival was observed for 60 kg/ha + 60 kg/ha and equally when all nitrogen was applied after reproductive development had begun. Split applications greater than 120 kg/ha total caused a decrease in tiller survival. No effect on the number of spikelets per spike was seen; however, higher rates of nitrogen applied after reproductive development did benefit the number of florets per spikelet. As with Pennfine, the Linn seed yields were not dramatically influenced by these rates of time of nitrogen application.

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[1] 1 kg/ha equals 0.89 lbs/acre

The most efficient use of nitrogen fertilizer results from a split spring application of 60 kg/ha applied during vegetative growth, followed by an additional 60 kg/ha after the transition to reproductive development. If, however, only one application can be made, Pennfine should respond more favorably when nitrogen is applied while the crop is developing vegetatively. Conversely, Linn perennial ryegrass would benefit from delaying the nitrogen application until after the onset of reproductive development.

Seed Yield Enhancement in Grass Seed Crops with Growth Regulators

D.O. Chilcote, H.W. Youngberg, W.C. Young, D. Ehrensing, D. Albeke, J. Hunter and C.C. Moon

Much of the potential seed yield created by grass seed crops is not realized in the final harvest of seed. Lodging in many of the grass seed stands contributes to this lack of realization of the full potential for seed yield. In addition, grass seed crops are developed for their forage and turf characteristics which are not always consistent with good seed yield. For these reasons, it appeared desirable to examine methods which would enhance seed production of grass crops in this region without altering their genetic constitution.

Growth regulators and, more specifically, certain growth retardants, have shown potential for enhancing seed yield in grass crops. With the need to be more efficient in our use of resources, a study on the use of growth retardants seemed desirable. Two new growth retardants with a different mode of action (soil activity) have given predictable and consistent results in terms of chemical dwarfing and lodging prevention. Positive grass seed yield results in England and in early tests at Oregon State University were the stimuli for continuing and extending research on growth retardants. The two compounds utilized in experiments conducted in 1980, 1981, and 1982, were Imperial Chemical Industry compound coded PP-333 and Eli Lilly compound coded EL-500. Research efforts were devoted to identifying the proper rate and stage of application as well as understanding the bases for yield increases. Effects on potential yield components, including heads/unit area, spikelets/head, and florets/spikelet, along with actual seed yield, were evaluated. Although these chemicals are still experimental, there is every indication that development to commercial use is a good possibility.

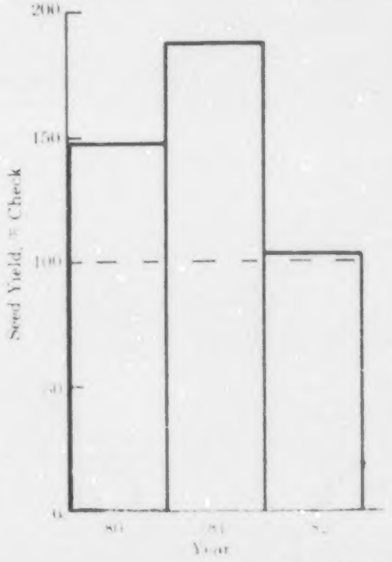
These compounds show consistent reduction in height and stem growth with very little effect on leaf area or reproductive development. Tests were conducted with different varieties of perennial ryegrass, tall fescue, fine fescue, orchardgrass, and bluegrass.

The 1980 results were very striking, with increases in yield ranging from 27-64%. In 1981, 54-150% increases in yield of ryegrass varieities were obtained. In both years, lodging was severe and occurred several days before anthesis. Unfortunately, bluegrass showed no such yield enhancement in either year. Bluegrass also appeared very sensitive to the growth retardant compounds, resulting in the need for testing lower rates in subsequent trials. Orchardgrass also seems to be quite sensitive to the compounds and lower rates of application will be evaluated in 1982-83.

A unique weather pattern in 1982, dry hot weather in May, and the subsequent effects on growth, led to inconsistent effects on seed yield. In general, seed yield increases were small or non-existent and although trends were similar to those in earlier years, variability within treatments was much greater. The average yield response comparing untreated control plots to growth retardant applications across varietieis of several species, including tall fescue, fine fescue, and perennial ryegrass, is shown in Figure 1. In 1980, an average yield increase of 47% was obtained. In 1981, the enhancement was even larger, 87% greater than the check. However, in 1982, little or no statistically significant yield response was observed.

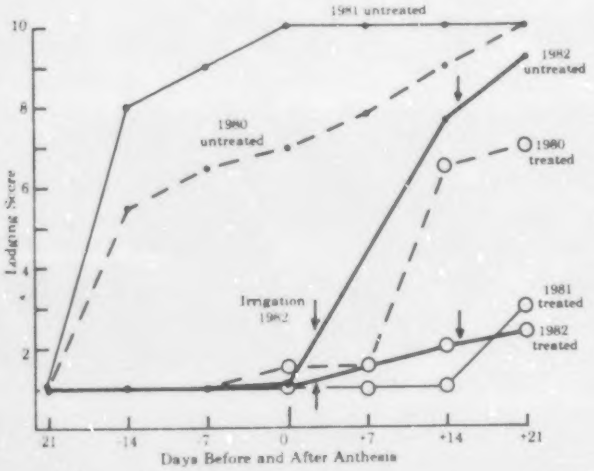
(continued)

Figure 1. Average seed yield response to optimum growth retardant application across different varieties of tall fescue, fine fescue and perennial ryegrass



Seed Enhancement (continued)

Figure 2. Lodging pattern for perennial ryegrass 1980-1982. Arrow indicates irrigation in 1982.



In Figure 2, lodging scores at various dates before and after anthesis are plotted for the years 1980, 1981, and 1982. In 1980, and to a greater extent in 1981, lodging was very severe several days before anthesis. In contrast, in 1982, lodging did not occur until several days after anthesis and then only after irrigation, which was provided to prevent severe damage to the experimental trials. Thus, in 1982, the lodging occurred well after seed filling was underway and this appears to be a major factor in the lack of seed yield response. Evidence of the unique weather pattern in 1982 was also seen in the lack of rust infection of the ryegrass, which usually is quite severe. The reduction in moisture availability and high temperatures early in the season (May) in 1982, could have affected the results in several ways. Since the growth retardant compounds are held fairly tight in the upper regions of the soil profile, the very dry conditions later in the season could have facilitated deeper root activity so that the amount of growth retardant compound taken up over the season would have been reduced, particularly in the later stages of development. The other factor was evidence of reduced total growth by the plants and reduced height. Therefore, the primary benefit of the growth retardant, lodging control, would not have been demonstrated under these conditions.

Another important observation in 1982 was the response differences among varieities within a species, perhaps due to differential growth and development rates under these rather unique weather conditions. Further study of cultivar response is definitely needed.

Studies on lodging control with growth retardant versus mechanical support indicated that the yield enhancement from the growtn retardant is due mainly to prevention of lodging, although some effects of differential dry matter partitioning were observed. The effects of changes in dry matter partitioning by reduced stem elongation were a minor part of the total yield effect in 1982. Results in 1982 showed again that seed filling appears to be benefited by the application of growth retardants.

Work with wettable powders and granular materials showed a benefit for the wettable formulation in terms of seed yield and further work may be necessary to determine if this same difference would occur under more normal weather patterns.

Germination results for 1982 substantiate the findings in 1980 and 1981, which showed no carryover effect of the growth retardant on seed germination or seed vigor.

Continued investigations are planned to more clearly define the optimum rate and date of application for different species and varieties of grass seed crops. Later growth stage treatment was superior under the 1982 weather conditions, so further study in this area is appropriate. The amount of moisture needed for activation and the effect of foliage uptake on effectiveness will also be investigated.

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Cereal Seed Yield Enhancement with Growth Regulators

D.O. Chilcote, H.W. Youngberg, and W.E. Kronstad

In Europe, it is a common practice to use dwarfing compounds (growth retardants) to reduce the height and prevent lodging in tall-growing cereal varieties, particularly wheat. Little work has been done in this country on growth retardants on cereals, in part because semi-dwarf varieties predominate and lodging in wheat is usually not a serious problem. However, there are occasional lodging problems, particularly in irrigated or high rainfall areas, especially where nitrogen rates are high. Other cereal crops, such as barley and oats, do have lodging problems. It was therefore of interest to determine if increases in yield of cereal crops could be obtained using an experimental dwarfing compound from Imperial Chemical

Industries, PP-333, which has worked so effectively in gras seed crops.

The objectives of this research were to identify the stage of growth and the proper rate of application of the growth retardant compound for optimum response. Studies were conducted at the Hyslop Agronomy Farm, with two varieties of wheat, Yamhill and Stephens, and a winter oat variety. Different nitrogen levels were used to assess yield benefits from reduced culm height and prevention of lodging, with the use of a growth retardant.

Because of the rather unique weather pattern in 1982, there was no lodging in any of the crops, even with the substantial increases in nitrogen application. The results show a trend toward higher seed yield in the taller growing wheat variety with the use of growth retardant (see Table 1), even though little reduction in height occurred. The compound seemed to benefit partitioning of dry matter to the seed (seed filling) since seed weight was enhanced (Table 1).

Table 1. Yield and thousand seed weight response from PP-333 treated Yamhill wheat at two nitrogen levels.

Treatment PP-333	Yield 134[1]	Yield 178[1]	Mean thousand seed weight
(g/ha)	(kg/ha)	(kg/ha)	(g)
0	6409	6925	48.77
75	6761	7759	50.93
150	6732	7923	51.53
300	6874	7192	50.26

[1] kg/ha N

Winter oat yields were not increased, although there were reductions in height related to rate and date of chemical application. In the absence of lodging, we would not expect major effects on final seed yields in either wheat or oats.

Work is continuing with the cereal crops. Studies will be conducted in 1982-83 in the Willamette Valley and in eastern Oregon at two locations, working with both wheat and barley, to further evaluate the potential for the use of these growth retardant compounds in enhancing seed yields.

The assistance of the following are gratefully acknowledged:
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Jim Hunter
Personnel of Cereal Project

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Potential Benefits in Grass Seed Production from Combined Use of Growth Retardants and Improved Spring Nitrogen Management

W.C. Young, D.O. Chilcote, H.W. Youngberg

Previous research results have shown growth retardant chemicals capable of improving grass seed yields by reduced or delayed lodging which improved light penetration into the canopy, tiller survival, and improved the processes of pollination, seed set, and seed filling (Chilcote, Youngberg & Albecke, 1982). Thus, there may be potential for using growth retardants to improve the efficiency of spring nitrogen used in seed production.

Nitrogen application in the spring will encourage the production of new tillers; however, the number of fertile tillers at maturity are less affected as those tillers destined to become fertile must compete with an increased number of vegetative tillers which subsequently died. Reduced lodging and improved light penetration should improve tiller survival and increase the total number of inflorescences per unit at harvest. Seed yield in grasses is a product of the number of inflorescences per unit area, seeds per inforescence and weight per seed. Growth retardants have improved the number of seeds per inflorescence without influencing the weight per seed. Therefore, if the survival of an increased number of spring-formed tillers is possible, the opportunity to improve upon fertile tiller densities at seed harvest may result from a combined use of spring nitrogen and growth retardants.

In a preliminary experiment in 1981, 120 and 150 kg/ha of spring-applied nitrogen significantly increased the number of florets per spikelet. This effect, combined with increased tiller survival due to ½ kg/ha of PP-333, resulted in significantly higher yields for Caravelle perennial ryegrass. A single application of spring nitrogen was made in the late spring (after floret initiation) during reproductive growth. Subsequent research has suggested that later maturing perennial ryegrasses could benefit from nitrogen applied early (or spit) by allowing spring-formed tillers to contribute to seed yield. Research is currently underway to investigate the interaction of date of nitrogen application with growth retardants.

Literature Cited

Chilcote, D.O., H.W. Youngberg, and D. Albeke. 1982. Potential for growth retardants in grass seed production. Crop Science Report EXT/CS 42, Oregon State University, February 1982.

AgIII-XIII-128

Post-Harvest Management Alternatives for Grass Seed Production

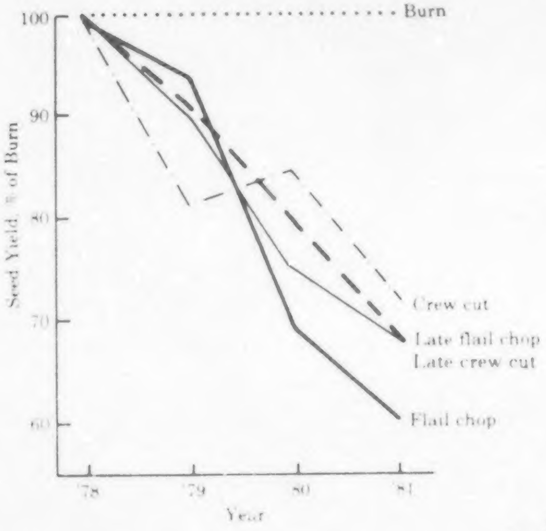
D. O. Chilcote, W.C. Young and H.W. Youngberg

Long-term effects of crew-cutting

The benefits of open field burning have been documented; however, continued concern over the contribution to air pollution from this practice has encouraged alternative research programs. The primary objective of this study is to investigate the long-term (4-5 years) effectiveness of close-cutting and removal of crop residues (crew-cutting) from grass species grown for seed production. Treatment effects through two (fine fescue and bluegrass) or three (perennial ryegrass) years have been reported (Young, Youngberg and Chilcote, 1982).

In perennial ryegrass, a definite pattern between burned and non-thermal treatments has become evident. The long-term effects of any treatment other than burning results in a reduction of seed yield. The yield reduction of all non-thermal treatments was 11% per year, resulting in a decline of 33% over three years when compared to continuous burning (Figure 1). Treatment effects have significant influence on growth and development of fine fescue. Continuous crew-cutting results in a more prostrate or creeping growth habit. However, crew-cutting has been successful in maintaining seed yields equal to burning over two years, and has been shown to be superior to the flail chop treatment. Similar treatment effects have been observed in bluegrass.

Figure 1. Mean seed yield of perennial ryegrass, shown as percent of burn treatment, plotting treatment effects across three years beginning in 1979 with 1978 shown as a base year.



Burning remains the most effective method for complete removal of straw and chaff, which results in improved herbicide efficiency and improved quality of the harvested seed.

Non-yearly burning

The objective of this research is to evaluate the feasibility of alternating either burning, crew-cutting, or flail-chopping in an effort to reduce the acreage of perennial grasses burned annually. Also, under study are non-yearly burning alternatives for annual ryegrass seed production.

In perennial ryegrass, continuous burning has been shown superior in the ability to maintain high seed yields (Table 1). Crew-cutting for one year followed by burning (B/CC/B) has not significantly reduced seed yield. Results from every third year treatments, B/CC/CC and CC/CC/B, reduced yields by 24% and 36%, respectively. Thus, seed yield cannot be maintained if crew-cut for two consecutive years following a burn, and will not recover by burning following two consecutive years of crew-cutting.

Table 1. Cumulative Effect on Seed Yield in the Non-yearly Burning Plots on Perennial Ryegrass, 1981.

Treatment 78/79/80	% of Annual Burning '78	'79	'80	3 year average
B/B/B	100	100	100	100.0
B/CC/B	100	97	93	97.7
CC/B/CC	99	99	52	83.3
B/CC/CC	100	97	76	91.0
CC/CC/B	99	83	64	82.0
B/FC/B	100	94	80	91.3
FC/B/FC	94	101	50	81.7

Seed yield is maintained in annual burning through an increased number of fertile tillers per unit area and a slightly greater seed weight. The less-than-annual burning study in fine fescue and bluegrass has been in progress through only two complete seasons. Seed yields in both crops appear to be reduced by burning one season out of two, as compared to annual burning. This response appears to be greater in fine fescue than bluegrass.

Establishing annual ryegrass without burning has not significantly reduced seed yield. However, seed quality is improved by annual burning followed by sod seeding. Sod seeding reduces competition from volunteer annual ryegrass plants; however, incorporation of straw residue plus using the herbicide ethofumesate (Nortron®) can maintain yields equal to sod seeding.

Literature cited

Young, III, W.C., H.W. Youngberg, and D.O. Chilcote. 1982. Agronomic and economic effects of crew-cutting and non-yearly burning programs in the Willamette Valley. Department of Environmental Quality Field Burning Report Volume 17C.

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Decomposition of Straw as Affected by Nitrogen Fertilizers and Mechanical Choppers

T.L. Jackson

Decomposition of straw (stubble) on grass seed and wheat fields is a major problem in the Willamette Valley. Preliminary research has shown that urea-sulfuric acid combinations reduce cellulose--the major component of mature grass straw--to more simple sugar molecules that decompose at a faster rate by biological systems. Other sources of nitrogen fertilizers sprayed on chopped stubble may increase crop residue decomposition rates. Increased decomposition of crop residue might reduce severity of some diseases.

The objective of the research is to evaluate the treatment of straw with urea-sulfuric acid, ammonium chloride to reduce yield losses associated with not burning stubble. Preliminary demonstrations in 1982 showed a 50% yield increase where urea-sulfuric acid was sprayed on a tall fescue field that was not burned.

Experiments were established on tall fescue, perennial ryegrass, orchardgrass, and common ryegrass during August and September, 1982. The effects of straw removal and treatment of straw with different nitrogen fertilizers on yield of these grass seed crops will be studied. Preliminary measurements on effects of these treatments on disease will be evaluated. This is the first year of this project. Treatment effects on seed yield will be recorded in 1983.

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Cooperative Study of *Epichloe typhina* Infection of Tall Fescue Clones and Open-Pollinated Progenies at Corvallis, Oregon and Lexington, Kentucky

Robert C. Buckner, USDA—ARS,
University of Kentucky and
Harold Youngberg, Oregon State University

Cattle grazed on tall fescue pastures in the southeastern U.S. that were infected with the fungal endophyte *Epichloe typhina* gain significantly less weight than those grazing noninfected pastures. The organism has been shown to be carried in the seed. Pastures planted with uninfected seed and kept free of infection produce greater animal gains. The objective of this study was to determine the effect of environment on reinfection of tall fescue plants under seed production conditions.

In an earlier study, breeders class seed of Kenhy, tall fescue which was infected with the fungal endophyte *E. typhina* produced foundation class seed in the Willamette Valley will less than 1% endophyte infection, while the foundation class grown at Lexington, Kentucky was heavily infected.

This study was undertaken to determine the effect of location on endophyte infection of a seed crop. Parental clones known to be infected with the endophyte and open-pollinated seed of those clones were established at Corvallis, Oregon and Lexington, Kentucky during the fall of 1980. The planting included 8 clones of the Kenhy variety and G1-307 (low perloline) strain that had been harvested during the spring of 1980. The clones were divided and established at both locations while the open-pollinated seed was seeded in spaced rows at both locations. Seed from these plantings was harvested during 1981 and 1982, at both locations.

The seed of parents and progenies were dried and processed by the usual method. Clean seed were examined for the endophyte by the ELISA (enzyme-linked immunosorbent assay) technique. Seed produced by parents and progenies at both Corvallis and Lexington were equally infected by *E. typhina* during 1981 and 1982. Therefore, it appears that the environment is not responsible for low level infection in progenies of highly infected parents of tall fescue.

AgIII-XIII-130

Grass Variety Seed Yield Evaluation

H.W. Youngberg, W.C. Young & D.O. Chilcote

The development and release of new varieties by private and public plant breeders is expanding. Growers are contracting to produce seed of these varieties and in many cases there is little information available to relate seed production potential to standard varieties. A pilot program was started in 1980 to compare seed yield potential of material available at this time.

One hundred forty-six entries were submitted for the trial. Species included perennial ryegrass, Italian ryegrass, Chewings and red creeping fescue, hard fescue, Kentucky bluegrass, orchardgrass and tall fescue. The perennial varieities were seeded in May 1981 and the Italian ryegrass seeded in October 1981.

First year seed yields were harvested in 1982 and summarized. A detailed report is available from the Crop Science Extension Office, Oregon State University. The publication is titled "Forage and Turf Grass Variety Seed Yield Trial - 1982", EXT/ACS 43. A second harvest measurement will be taken if funds are available.

A new trial planting is planned for May 1983. An entry fee will be charged.

Seed Productivity and Management of Timothy for Seed Production

H.W. Youngberg and W.C. Young

Late-maturing forage-type and turf-type timothy varieties may have potential for seed production in western Oregon. A timothy variety and management trial was established in 1980, at Hyslop Farm near Corvallis to evaluate certain practices.

Eleven varieties of timothy were established. A significant difference in seed yield potential was observed among them. The range of seed yield of the best variety was 4.4 times the poorest in 1980 and 10.5 in 1981. The ranking was consistent in the 3 years. Late-maturing varieties may have suffered more from drought stress than early varieties. Lodging was a serious problem with some varieties.

Stubble burning is not a common practice in timothy seed production because tillers are more subject to heat injury than in other species. A study was made of the response of 5 varieties to a flame treatment applied by a propane flamer following harvest in 1980 and 1981. The autumn vegetative growth in the flamed plots appeared more vigorous than when stubble was removed with a flail chopper. A slight increase yield was associated with burning in both years.

The study suggests that turf-type timothy may be a profitable seed crop for the Willamette Valley. There is a wide range in seed yield potential among available varieties. Care should be taken to select a high yielding variety or be assured of compensating seed prices.

Wheat Variety Identification by Laboratory Methods

Aomar Ait Amer and D.F. Grabe

There is an increasing need for development of laboratory variety identification procedures for purposes of plant variety protection, seed certification, quality control and consumer protection. As the number of varieties grows, visual differences become smaller, and the task of identification becomes increasingly difficult. Field testing methods often require too much time to be of practical use. This study was initiated to investigate various morphological, chemical and biochemical characteristics of 25 white wheat varieties grown in the Pacific Northwest. On the basis of these findings, an identification key to the varieties was developed.

Morphological studies were based on coleoptile color and pubescence of the sheath and leaf buds. Each of these characteristics separated varieties into two distinct groups; i.e., purple or green coleoptile, and pubescent or non-pubescent sheath and leaf blade.

Chemical studies were based primarily on variety responses to phenol treatment. Varieties in this study were separated into light brown and dark brown color groups.

Biochemical studies involved electrophoresis of gliadin proteins and peroxidase, esterase, catalase, acid phosphatase and glutamic oxalacetic transaminase enzymes. Several varieties developed different gliadin electrophoregrams and could be easily separated. Closely related varieties, such as Gaines and Nugaines, and Fielder and Fieldwin, developed identical patterns. Except for peroxidase, all varieties developed the same enzyme patterns. Peroxidase electrophoresis divided the varieties into two different groups.

It is not possible to distinguish individual varieties with any single test, but they can frequently be distinguished by using a combination of tests. For example, McDermid and Hyslop are similar electrophoretically, but can be distinguished by their different phenol staining patterns.

Cause of Growth Termination in Wheat Seeds

Andy Huber and D.F. Grabe

It has been well documented that larger seeds produce more vigorous seedlings and greater total yield. However, the factors which bring about the termination of seed growth and limit seed size are poorly understood. In the grass family, seed size is determined mainly by the growth of the endosperm. This study was conducted to determine the factors which result in the termination of cell division in the endosperm. Wheat was chosen for this study because of its relatively large seed size. The developing seeds were harvested each day after fertilization until maturity. Sections were cut for microscopic examination of the whole caryopsis.

The study is nearly completed and the results are being prepared for publication. The morphologic changes which result in the termination of endosperm growth have been identified. Ultimately, the extent of endosperm cell division is limited by the growth of the surrounding maternal tissues. Likewise, the termination of endosperm cell division occurs because a proper microenvironment for cell division is not maintained between the endosperm and nucellus.

This information is essential for efforts to breed grass and cereal varieties for extended seed growth. Selection for genotypes with greater growth capacity of the inner integument could lead to larger and more vigorous grass and cereal seeds.

Establishment of Grass Seed Crops with Cereal Companion Crops

Jeroen deHass and D.F. Grabe

One of the serious problems associated with seed production in Oregon is that many perennial grass seed crops are normally established with a cereal companion crop to prevent the loss of a year's income. The objectives of this project are to: (1) determine the feasibility of establishing grass seed crops with cereal companion crops in Oregon, (2) identify optimum cultural practices for companion cropping to maintain grass seed production at acceptable levels, and (3) measure the competitive effects of the companion crops on the grass seed crop.

The following conclusions are drawn from the 1980-81 and 1981-82 trials with Kentucky bluegrass and orchardgrass established with a wheat companion crop:

(1) Light transmittance through the wheat canopy was greater when the wheat rows were parallel to the grass rows than when planted across the grass rows.

(2) Light transmittance through the wheat canopy was similar at 67.2 and 100.8 kg/ha planting rates.

(3) The number of tillers, leaf area index and specific leaf weight of Kentucky bluegrass and orchardgrass were suppressed by the presence of the companion crop, while tiller height and leaf area per tiller were increased.

(4) Soil water potential remained higher during June and July in plots with a companion crop.

(5) Stephens winter wheat produced low yields (3075 kg/ha) in the Gervais plots in 1981, due to Septoria leaf blotch and a heavy weed infestation. Kentucky bluegrass seed yield in 1982 was 280 kg/ha higher when planted without a companion crop. Returns on the wheat crop did not compensate for the extra costs of cleaning up the field after harvest of the wheat and the lower grass seed yield the following year.

(6) Yields of Stephens winter wheat at Hyslop Farm in 1982 were high. Visual examination of the stand of the grass seed crop indicates that grass seed yields in 1983 can be expected to show the same type of response to companion cropping as did Kentucky bluegrass in the 1982 experiment at Gervais.

(7) Fields on which the companion cropping system is to be practiced should be fairly free from weeds to prevent weed control problems from occurring.

Maturation of Subterranean Clover Seed

Chuck Mouwen and D.F. Grabe

Subclover seed is presently harvested with vacuum harvesters after the plants have died down in the fall. At this stage, the seed burs are mostly detached from the dried plants and lying on or near the soil surface. Vacuum harvesters are extremely slow, covering about ½ acre per hour. One possible alternative to the vacuum harvester would be to develop a windrower that would cut the plants at ground level while the plants are still green and the burrs are still attached to the plant. Success of such a system would depend on a knowledge of when the seeds are mature and can be safely harvested.

The objective of this study was to determine when seed maturity is reached in seeds of Mt. Barker and Nangeela subclover. Maturity indices included seed weight, moisture content, germination, and seedling vigor.

In 1981, maximum seed dry weight was attained 38 and 40 days after flowering at moisture contents of 55 and 57% for Mt. Barker and Nangeela, respectively. In 1982, maximum seed dry weight was attained 37 and 43 days after flowering at moisture contents of 54 and 52% for Mt. Barker and Nangeela. Germination reached 90% on the 26th day after flowering. Maximum seedling vigor, however, did not occur until maximum seed weight was attained. During early development, the seed coats were permeable to water, but by July 15, 95% of the seeds had developed hard seed coats which were impervious to water.

AgIII-XIII-132

Seed Harvesting and Conditioning

A.G. Berlage, N.R. Brandenburg, P. Krishnan, D.M. Bilsland, and T.M. Cooper (USDA-ARS)

Seed conditioners frequently are unable to remove contaminants efficiently from seed lots when using conventional separators. This problem is aggravated by increasingly restrictive tolerances for weed seed, soil particles, and other contaminants in seed lots being cleaned to meet certification or export requirements. Inadequate removal of contaminants may result in a lower grade and value of seed, a reduced yield of acceptable seed, or complete rejection of the seed lots.

Seed cleaning equipment manufacturers devote relatively little effort to the development of new or improved seed-conditioning equipment because potential sales of such new machines do not justify large research and development costs by manufacturers. To meet the need for improved seed separation capability, this project is conducting engineering research aimed at the development of improved equipment and techniques for conditioning seed.

Objectives of this research effort are to develop seed conditioning equipment that will reduce contaminants, minimize seed losses, improve germination, lower seed damage, improve efficiency, and reduce costs.

Projects are currently underway in three general areas: (1) Establishing new or modified concepts for making seed separations; (2) Developing experimental conditioning machines; (3) Determining effective techniques for separating seed mixtures representing industry problems.

Seed Scarifier

Scarification refers to any procedure that modifies the outer protective layers of hard seeds to permit the entry of water and the exchange of gases, and allows the developing seed embryo space for growth, thus improving germination. In the vegetable, herb, flower, and forage legume seed industries, seed scarification is a desirable procedure for conditioning some seeds prior to planting. Commercial scarifiers generally lack adequate control and frequently damage seed.

An experimental device for scarifying seeds was designed, built, and tested. It allows continuous controlled operation with several degrees of aggressiveness to accommodate seed types with varying scarification requirements and susceptibilities to damage.

Scarification trials were conducted with several seed types and evaluated by standard germination tests. In most cases, the machine effectively reduced hard-seed content and improved germination values. Hard-seed content of arrowleaf clover was reduced from 74 to 6% while normal germination increased from 24 to 86%. For alfalfa seed, the changes in hard seed and normal germination were from 14 to 1% and 71-80%, respectively; for geranium seed, 65 to 1% and 31 to 96%; for lupine seed, 62 to 0% and 37 to 99%; for dichondra seed, 22 to 7% and 53 to 68%; and for morning-glory seed, 24 to 0% and 68 to 93%.

Where scarification is desirable, it may offer considerable benefit. For example, if the time required for acceptable germination levels for a hybrid geranium seed is decreased by 65%, the overall planting-to-marketing time for the bedding-plant industry can be reduced about 25%. In addition, scarification can increase crop yields, produce more uniform stands, and reduce volunteering in subsequent crop years.

Special Indent Separator

A commonly used seed separator is the indent cylinder which separates on the basis of length differences. Short seeds or contaminants rest in indents located on the inner surface of a horizontal cylinder and are lifted from a contained seed mass as the cylinder rotates. When the lifted items fall from the indents, they are collected and transported out of the machine.

Indents of the usual commercial cylinders are hemispherical with rounded shoulders, but other indent shapes also have been proposed and evaluated. An early USDA ARS design used straight-side indents provided by round-hole perforated metal backed by sheet metal. This special indent cylinder showed good separating capability, but was subject to plugging or lodging of seeds in the indents. A new version of the special cylinder has been designed with a "self-cleaning" feature to correct the plugging problem. The new version uses a thin flexible belt rather than sheet metal to enclose the cylinder of perforated metal. A roller supports the belt above the cylinder to provide space to mount a rotary cleaning brush whose bristles penetrate the perforations and force plugged seeds out of the indents.

Performance trials with the machine have shown the self-cleaning feature to be very effective when removing pigweed from alfalfa. At feed rates from 165 to 675 lb./hr., the brush-cleaned section showed an 1800-fold reduction in the rate of indent plugging while removing from 60 to 90% of the pigweed with crop losses of 2% or less.

A successful development of this type will make it possible to improve the selectivity of many separations now being made on the basis of length differences. In addition, separation of other mixtures are not now feasible with commercial indent cylinders will become possible.

Magnetic Fluid Separation

Some seed lots are now separated magnetically if the contaminants are sufficiently different from the crop seeds in texture. When such lots are pretreated conventionally by the addition of iron powder and moisture, the rough or sticky contaminants, but not the smooth crop seeds, pick up the iron powder.

A separation can then be made by passing the treated lot over a magnetic drum that attracts the iron-coated items away from the uncoated crop seeds.

An investigation is now underway using a newly-available magnetic fluid to pretreat the seed lot. The fluid is a colloidal suspension of submicron-sized ferrite particles in a liquid carrier (kerosene, heptane, silicone, flurocarbon, or water). The fluid is truly magnetic, and the fine iron particles remain in suspension permanently due to an added dispersing agent. Separation trials of soil particles from bentgrass seeds were carried out using three dilution rates of the fluid and four magnetic field intensities of the magnetic separator. A specific aim was to reduce soil particles to a level of 0.03% by weight to meet phytosanitary tolerances for bentgrass lots being exported to Japan. The test separations were evaluated by purity and germination tests of the resulting fractions.

It was found that the soil particles readily absorbed the magnetic fluid and could be removed from bentgrass along with some crop loss. The best results were usually obtained with the greatest fluid dilution and the greatest magnetic field intensity. Under these conditions, soil particles were reduced from an initial level of 0.30 to 0.03% or less. Crop loss averaged 30%, but this fraction is not an actual loss. All or most of this reject material can meet purity standards where phytosanitary restrictions regarding soil particles are not applicable. The fluid treatment and magnetic field exposure had no adverse effect on germination capability, but the bentgrass seeds were slightly discolored by the fluid.

This technique needs further investigation to examine application methods, seed drying requirements, effect on seed marketability, and potential application to other seed/contaminant mixtures.

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Nursery Production

Plant Science -- Local Adaptation

Introduction:

This unit is a Plant Science Local Adaptation Unit. There are six provided in this guide. Select the one which best fits your local community needs. The six units include:

1. Berry Production
2. Grass Seed Production
3. Nursery Production
4. Landscape Design
5. Christmas Tree Production
6. Range

Objectives:

Upon completion of this unit, the student will be able to:

1. Select an appropriate site for a nursery (wholesale or retail).
2. Plan the physical layout for an efficient nursery operation.
3. Propagate nursery stock.
4. Select containers.
5. Understand the production cycle of common nursery plants.
6. Use hand and power tools and equipment safely.
7. Understand the importance of media.
8. Select media for various jobs.
9. Fertilize nursery plants.
10. Prune and shape nursery plants.
11. Transport nursery plants to minimize damage.

12. Price nursery stock.
13. Know how to sell nursery stock.
14. Irrigate nursery stock.
15. Know and identify common nursery stock.

References:

1. This unit was developed from "Nursery Production" Student materials published by the Agricultural Education Department, University of Arizona, Tucson, Arizona 85721.
2. An outstanding text for ornamental horticulture instruction is "Introductory Horticulture", Delmar, 1979. This would be an option if you decided not to use the materials presented here.
3. An excellent text for Greenhouse Management is "The Commercial Greenhouse", Delmar, 1981.
4. "Working in Horticulture", McGraw-Hill, 1980, is an excellent text for introduction to ornamental horticulture also.
5. Certified Nurseryman's Manual, Oregon Association of Nurseryman, 0224 S.W. Hamilton, Portland, Oregon 97201. Plant materials for Oregon are in this publication, a copy is provided for your use in Appendix A.

Instructor Activities:

1. Either copy the materials presented here or purchase them from the University of Arizona.
2. Use local nursery for guest speakers and field trip hosts.
3. Use the extension nursery specialist for help with the technical materials as needed.

Student Activities:

1. Read and discuss materials.
2. Perform activities in laboratory.
3. Develop a plan for starting a wholesale or retail nursery operation.

Appendices:

1. Appendix A: Plant Names -- Certified Nurseryman's Manual
Oregon Association of Nurseryman
0224 S.W. Hamilton
Portland, Oregon 97201

TABLE OF CONTENTS

Page

- Foreword 1
- Acknowledgements 2
- Table of Contents 4
- INTRODUCTION 7
- SITE SELECTION 8
  - Wholesale Container 8
    - Site Physical Features 8
    - Market Proximity 9
    - Location 9
    - Environmental Conditions 9
  - Retail Garden Center 10
    - Town Size 10
    - New Areas of Urban Development 10
    - Location of Shopping Centers 11
    - Highway Access 11
    - Shape and Size of Property 11
    - Local Zoning Regulation 11
- PHYSICAL LAYOUT 12
  - Wholesale Production 12
    - Linear 12
    - Curvilinear 12
    - Circular 12
  - Retail Garden Center 16
    - Layout 17
    - Structure 18
    - Growing Area 19
    - Sales Area 20
- PLANT SELECTION AND CLASSIFICATION 21
  - Climatic Factor 21
  - Customer Preference 22
  - Sizes and Types 22
  - New Varieties 23
  - Plant Classification 23
- WHOLESALE NURSERY PRODUCTION 24
  - Propagation 24
    - Plant Material 24
    - Management Practices 25

Page
Container Selection 27
    Influence of Cultural Practices. 27
    Cost of Production 28
    Cost of Marketing. 30
Production Cycle. 30
    Liner Production 31
    1-Gallon Container 31
    3 and 5-Gallon Continers 32
    Larger Specimens 32
    Other Methods. 32
Tools and Equipment 32
Growing Media and Mixes 34
    Support. 34
    Moisture Holding Capacity. 34
    Nutrition. 35
    Aeration 35
    Sterilization. 35
    pH Level 36
    Physical Components. 37
Fertilization and Fertility 38
Pruning and Shaping 46
Transportation. 47

RETAIL GARDEN CENTER NURSERY. 48
Retail Handling 49
Pricing and Labeling. 49
Sales 51

WATERING AND IRRIGATION 53
Irrigation Systems. 54
    Individual Container or Spaghetti. 54
    Subirrigation. 55
    Overhead Sprinkling. 55
Water Supply. 56
System Design 57

APPENDIX A

Description of Common Landscape Plants. 59

NURSERY PRODUCTION

INTRODUCTION

The production and sale of plants in the nursery is a vital segment of the ornamental horticulture profession. Successful nursery management is the manner of producing and marketing plants so that a nursery may achieve its objectives. Specific objectives of a nursery depend upon the types of ornamental plants produced and marketed, and the type of nursery.

The trend in nursery production leans toward container-grown plants. In the future most ornamentals will be sold in containers. Production technology will advance as practices are developed, improved, improvised, and otherwise modified although the market place will determine size, form, and shape.

There are many routes for plants from producer to landscape. The two most common are: 1) producer → landscape contractor → landscape, and 2) producer → retailer → consumer → landscape. For the first case, whether the planting is a large one as in an industrial park or highway planting strip, or modest like that in a home landscape, the contractor purchases the plants from the producers and plants them into the landscape, often with direction and guidance from a landscape architect. The owner or users of the completed landscape accept the kinds of plants and landscape picture created. The owner has little, if any, interest in how the plants are packaged before planting. The contractor purchases directly from the producer, and is most interested in obtaining excellent plants at a reasonable price, and those that present no unusual or special problems during the planting operation. He also wants all of the plants to survive.

When plants move through the hands of retailers directly to the consumer, the plants are usually sold in small quantities. Production of a marketable plant must be oriented toward ease of handling and attractive display. Here, too, all factors important to a contractor are also important to consumers, although on a smaller scale.

Container-grown plants offer many distinct advantages for both types of market outlets. They may be transplanted at any time of the year, so that sales may continue year round. Before the appearance of container culture, plants were transplanted only during the dormant season. With the minimization of the problem of survival, plants may now be offered for sale when they are at their attractive best; when the consumer desires them; or wants to work outdoors on improving the home landscape.

Container plants insure better survival in the landscape following transplanting. With both the bare root and balled and burlapped (B & B) plants, a larger part of the root system is removed when the plants are dug for sale. With container plants, all of the root system is contained in the ball when sold. It is, however, necessary to prevent girdling root systems.

Container-grown plants make more attractive retail displays. The more attractive the displays, and the more convenient and easier to handle the individual "packages", the greater will be the consumer's acceptance of the plants.

Before the use of container-grown plants, consumers had to buy plants when they were ready for transplanting. Container-grown plants, however, may be offered to the consumer, when, where, and how they are desired.

SITE SELECTION

In production nurseries, location greatly influences profit and even survival. A poor choice of sites may result in at least one of the following difficulties: (A) higher production and marketing costs, (B) less income - fewer sales, (C) unfavorable environment, (D) poor or undesirable plant growth, (E) greater production time, and (F) supplies and/or labor not available.

A good site selection involves the simultaneous consideration of the economic situation, marketing and crop specifications, size and scope of operation, marketing methods, transportation and distribution, layout of the nursery, and environmental conditions.

Site selection and development of the nursery also has much to do with the type of nursery, i.e., wholesale container or retail garden center.

Wholesale Container

When planning a site for wholesale container nursery, several factors should be considered. These include site physical features, market proximity, location, environmental conditions, plan for expansion and land acquisition, and central location.

Site physical features: A slightly sloping land area is best for nursery layouts since it allows for excellent air and surface water drainage. A site with poor air drainage, such as valleys and low areas, can create cold air pockets that injure plants. Insect and plant disease damage is often more severe where air and surface water drainage are poor.

Of all the necessities of plant growth and development, a source of high quality water is the most important. There must be an adequate supply of water throughout the plant's growing season and especially during peak usage periods. Between 5 to 10 acre feet of water are needed to supply one acre of plants per year. To insure that an adequate supply of water is available throughout the year, it is recommended that the nursery have at least two sources of water.

Market proximity: A wholesale nursery should be located at least 200 miles from the retail market. Generally the further away the grower from his market, the larger the deliveries he can make at one time. This reduces such costs as transportation, labor, assembling, handling, and unprofitable small deliveries.

When several nurseries are located near each other, there are a number of mutual benefits they may share. Benefits that may be derived include an exchange of ideas and information, marketing sources, personnel and equipment, transportation, cooperation on shipments, and others.

Location: The location of the wholesale nursery business is an important factor in site selection. In order to keep costs at a minimum the nursery should not be located near a populated urban area. The closer one is to a populated city, the higher the labor costs, property taxes, land prices and goods and services. Air pollution near municipal areas is also greater and may cause abnormal plant growth and damage. The availability of such utilities as water, electricity, and fuel must also be considered. When buying land for a nursery, plan for future expansion. Purchase enough land to allow for an increase in nursery volume.

Environmental conditions: Ideal environmental conditions for nursery sites vary with plant types and production methods. Environmental conditions include the temperature, light intensity, wind, frost, hail, and rainfall. The nursery manager when selecting a nursery site should consider daily, monthly and seasonal temperature fluctuations, and avoid extremes in temperature. Young nursery stock may be killed in large numbers if grown where temperatures drop suddenly in winter or are excessively hot in summer. The nursery should not be placed in an area where there is constant cloud cover; thus reducing light needed for photosynthesis. On the other hand, nursery stock should be protected from excessive light intensity. Windbreaks are used in areas of high winds to protect the plants from wind damage. Areas with a history of frost and hail should be avoided.

Ideal environmental conditions also vary depending on whether the manager decides to produce container-grown or field-grown stock. The optimum temperature range for container-grown stock is between 60° and 85°F. Temperatures below 28° will cause frost damage. Suggested surfaces for placement of container-grown stock consists of gravel and asphalt. Gravel surfaces are preferred over asphalt because asphalt will hold and radiate more heat.

Environmental conditions for field grown stock include soil type, pH, and the presence of soil pathogens. For bare rooted stock, a light sandy soil is preferred for easy removal. B & B stock require a heavier textured soil (loam or clay-loam) that will adhere to the root ball. A broken soil ball means damaged roots, and possible death of the plant. Sandy soils will produce a faster growing plant, whereas plants growing in a heavier textured clay soil have a longer growing season due to heat retention. The soil pH should be slightly acid ranging from 5.5 to 7.0.

Special soil mixtures are used for container-grown stock, and an adequate source of good soil must be available for producing plants in this manner. Sometimes nurseries must acquire land in two or more locations in order to satisfy the soil needs of different kinds of plants.

Retail Garden Center

In locating a retail garden center the nurseryman has to consider town size, new areas of urban development, location of shopping centers, highway access, shape and size of property, and local zoning regulations.

Town size: When planning a retail garden center, the first consideration is the size of the town in which the center is to be located. The nurseryman must consider other nurseries in the town and their volume of business, and the amount of business he can expect. Unless the town is large or draws considerable business from the surrounding area, the garden center may not be profitable due to lack of customers. In general, the chances of success are best in areas of large populations, where there is little or no competition.

New areas of urban development: Areas of new urban development provide retail garden centers with new prospective customers. People usually purchase landscape materials from nurseries located near their homes. Many of the successful retail garden centers or nurseries have considered this factor when locating their nursery.

Location of shopping centers: Many of the retail nurseries in Arizona are located near or within shopping centers. Locating the garden center near or within a shopping center makes the purchase of landscape materials more convenient for the average shopper. Many department store chains in Arizona have a small garden center adjacent to their stores.

Highway access: The garden center must be easily accessible from the highway. If the center is located adjacent to a busy intersection that is difficult to get into or out of, total overall business may be reduced. Prospective customers will be turned away because of the inaccessibility of the garden center. Garden centers located hear a shopping center usually do not have this problem. In this instance, highways to garden centers are usually readily accessible and plenty of free parking space is available.

Avoid locating garden centers on high-speed highways. It is not only difficult but dangerous to turn off the highway when traffic is traveling at high rates of speed. Unless the customer is familiar with the location of the nursery, he may not be able to slow down in time to turn into the garden center's driveway or parking lot. When the traffic moves more slowly, the customer is more relaxed and is more likely to see the nursery and make up his mind to stop.

The garden center should not be located where visibility is less than 200 to 300 feet in both directions. Limited road visibility means a traffic hazard to the customer.

Shape and size of property: The size and shape of the property acquired for the garden center is important. Size of the property, of course, depends upon the volume and type of establishment. If the nurseryman plans to grow his own stock, more land will be needed for the garden center. Ample land should be purchased to house all features of the garden center (parking lot, store, storage buildings, office, lathhouse, work area, etc.) and for future expansion. It is better to acquire more than needed, then if it is not used in can be sold.

The piece of property on which the garden center sits should have ample frontage. Ample frontage not only permits more parking space, but is more inviting to the customer. A long narrow piece of property parallel to a road is better than one of the same size at right angles to the road.

Local zoning regulation: Before nurserymen purchase any property for a garden center they must investigate existing zoning regulations. Some property may be zoned against business. Depending on local regulations, oftentimes, nurseries may be permitted to operate in areas zoned for residential homes.

PHYSICAL LAYOUT

Once the site for the nursery has been chosen, the arrangement of the buildings and growing area must be planned, for the present as well as the future. Facilities and equipment must be placed and so arranged to allow for their most efficient use. Plan to utilize mechanical equipment as much as possible and only allow for short distance moves. This will shorten and save man-hours; thus reducing labor cost which is the greatest incurred cost.

Wholesale Production

Wholesale nurseries vary in size from 40 to 700 or more acres. The average wholesale nursery covers about 135 acres and employs approximately 17 full-time personnel. More people are usually employed on a part-time basis during peak workload periods.

The buildings and growing areas in a wholesale nursery are generally arranged in a kind of assembly line based upon the steps involved from the propagation of the plants to the shipping of them. There are three basic wholesale nursery layouts; namely, linear, curvilinear, and circular.

Linear: In the linear layout all facilities are so arranged that all moves within the nursery are in a straight line with each section separated from the other. Figure 1 shows a diagram of the linear layout. Each division and growing area has its own separate complete facilities. This layout arrangement duplicates preparation and storage areas resulting in increases in equipment, building, and labor costs.

Curvilinear: Plant material flow in a curvilinear layout is in a circle as illustrated in Figure 2. All production divisions share the same central storage and preparation area. This arrangement allows for the office, receiving, and shipping facilities to be together.

Circular: The circular arrangement is the most efficient type of nursery layout utilizing less travel distance (see Figure 3). All sections utilize and share the centralized storage area and preparation areas. The growing area surrounds the entire operation, thus sharply reducing travel distance, time and production costs.

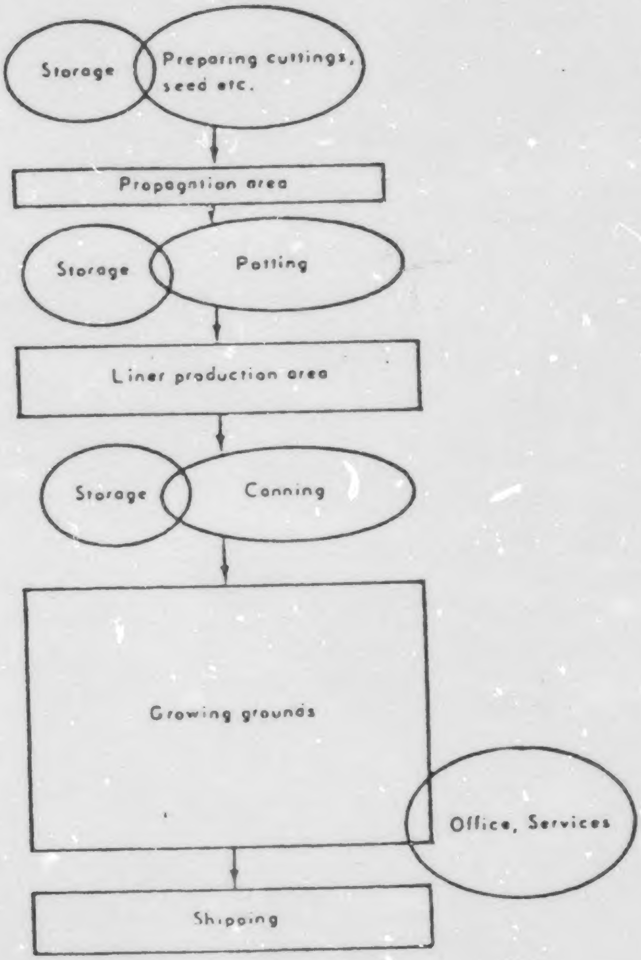
Storage
Preparing cuttings, seed etc.
Propagation area
Storage
Potting
Liner production area
Storage
Canning
Growing grounds
Office, Services
Shipping

Figure 1. Linear Layout in a Wholesale Nursery

(Source: Futura - Site Selection & Development, University of California Nursery Management Handbook - Section 3)

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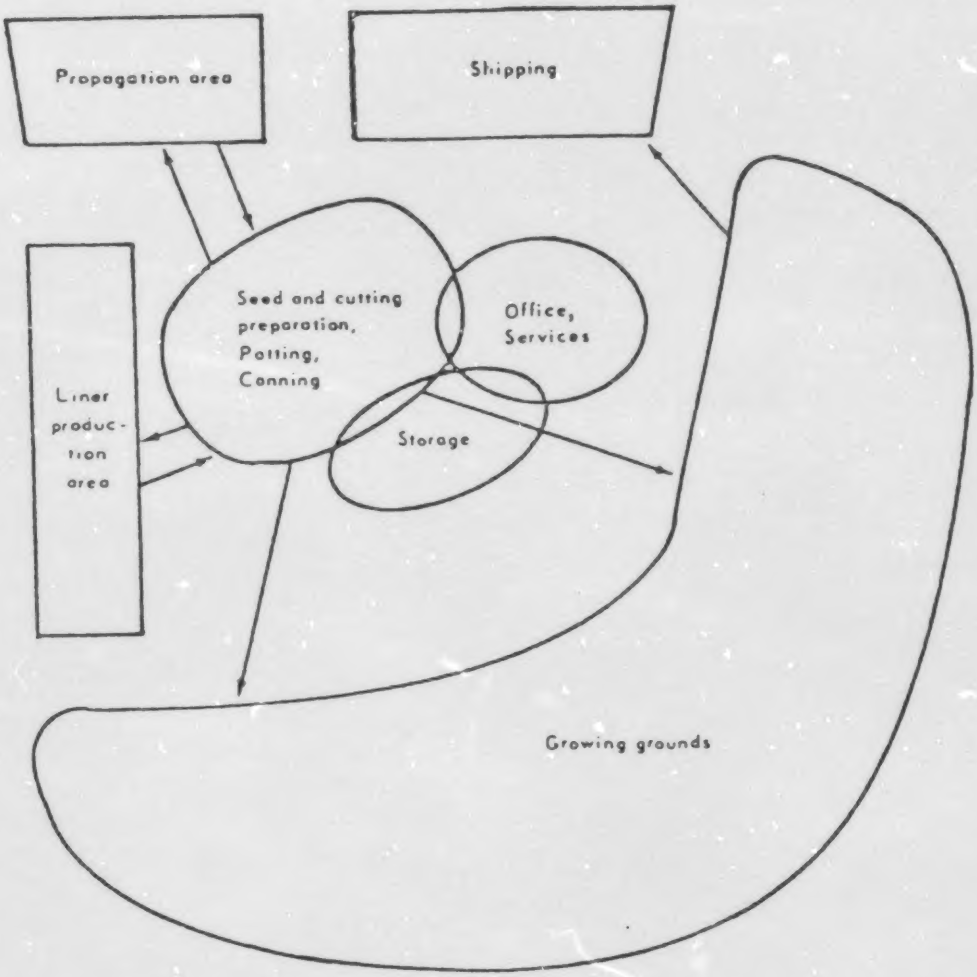
Propagation area
Shipping
Seed and cutting preparation, Potting, Canning
Office, Services
Liner production area
Storage
Growing grounds

Figure 2. Curvilinear Layout

(Source: Furuta - University of California Nursery Management Handbook - Section 3)

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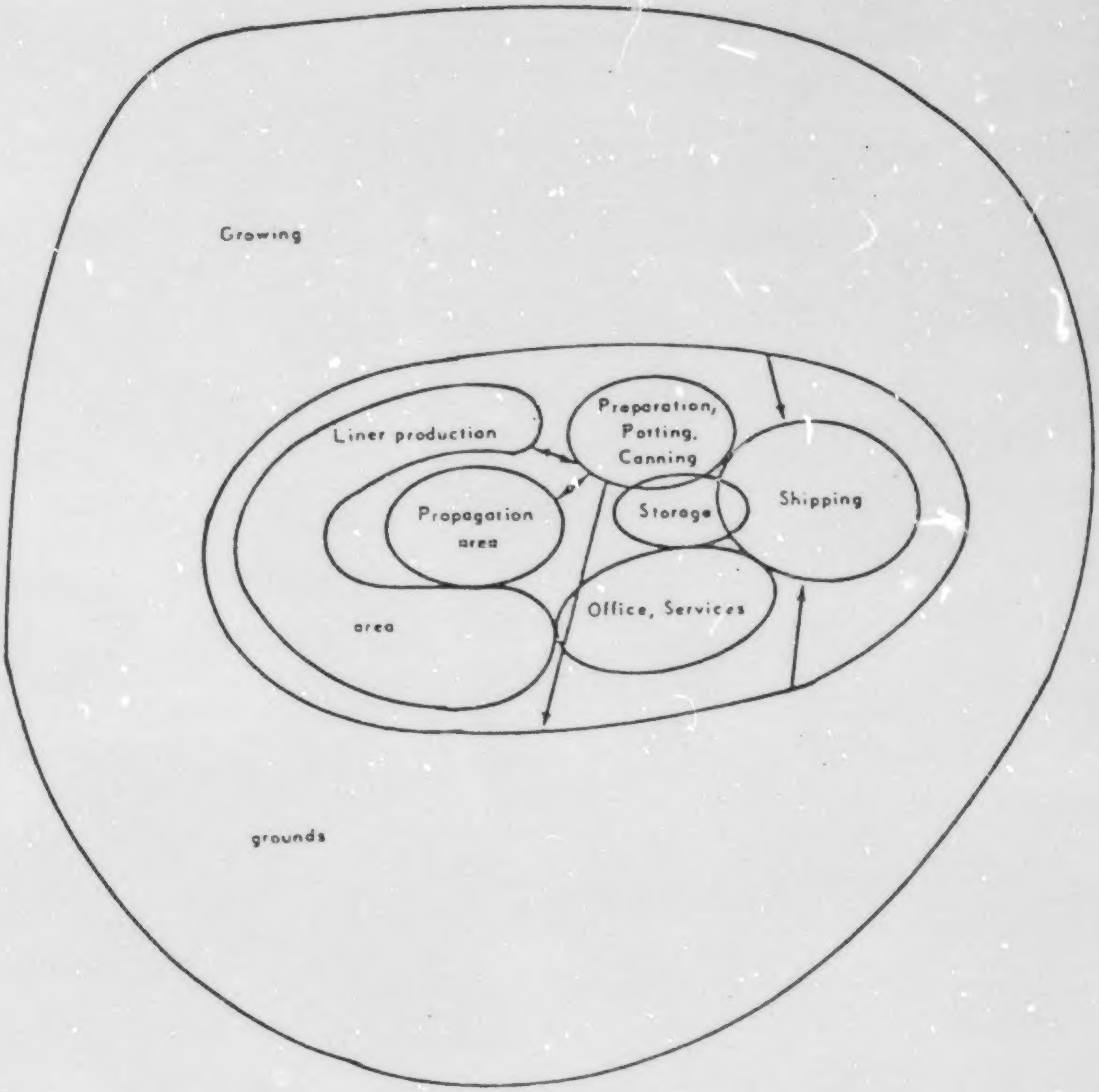

Growing
Liner production
Preparation,
Potting,
Canning
Shipping
Propagation
area
Storage
Office, Services
area
grounds

Figure 3. Circular Layout
(Source: Furuta - University of California
Nursery Management Handbook - Section 3)

The facilities in these various layouts include structures for propagating and growing of small plants. Equipment facilities and supply buildings also include material storage rooms, grading and preparation rooms, potting and canning areas, holding shelters and loading docks. As stated earlier, these facilities are arranged in a pattern following the various steps the plants go through from propagation to marketing.

To allow necessary equipment operation within these structures the recommended building height should be at least eight (8) feet. Post and aisle arrangement must also be planned to accommodate equipment usage. Storage areas should be centrally located for maximum efficiency. There are four main types of storage areas located within the nursery; namely, outdoor, dry, cold and shipping-fumigation. All storage areas must be readily available for usage by all production divisions. Table 1 shows the items stored in each type of nursery structure.

TABLE 1

Storage Areas

Structure Type	Items Stored
Outdoor	Soil, organic amendments, containers, flats, etc.
Dry	Chemical, fertilizers, etc.
Cold	Seeds and cuttings to remain dormant, and regulating special flowering cycles as azaleas, poinsettias, and lillies.
Fumigation & Shipping	All plants prior to shipment.

Retail Garden Center

The garden center should be carefully planned. The layout should be planned in such a manner that future expansion can be accomplished without encroaching on other areas of the nursery. The plan should provide a clean, well-groomed appearance which is relaxing to the customer. Thorough planning will help eliminate costly mistakes.

Layout: Plans for the retail garden center should include provisions for such facilities as a parking area, sales area, growing area, office and work area and for future expansion. Figure 4 illustrates a plan for a practical retail nursery layout providing adequate area for the present facilities, as well as for future expansion.

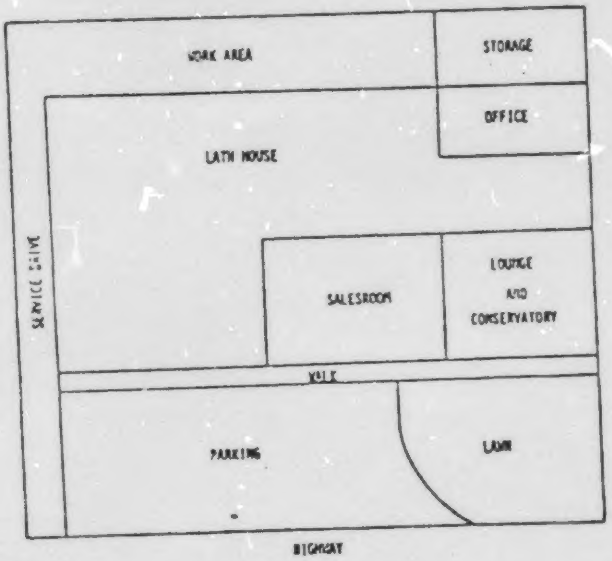


Figure 4. Retail Garden Center Plan

The parking area for a retail nursery should be well marked and easily accessible. It is a good idea to have the cars parked facing the front of the garden center so the landscape plants will be easily visible. The parking area should be located near the garden center sales area, so customers will have a minimum distance to carry purchases.

The entrance to the sales area must be well-marked for it is the center of the nursery operation. Customers are often discouraged, embarrassed or annoyed when they do not know where to go to talk with a salesman or to pay for purchases. Many customers leave before a salesman has a chance to sell them anything because they become discouraged.

An area for growing plants is another item that should be considered when planning the layout of a garden center. This facility should be adequately covered to protect nursery stock from high temperatures and bright sunlight. This cover, usually lath or saran, will also provide shade for customers while shopping for nursery stock. The plants should be arranged to provide easy access throughout the nursery by the customers. A common error in planning a garden center is to separate the sales area from the lathhouses or growing area. This makes it inconvenient for customers to go from one place to another.

The office and work area should be screened from public view. Customers should not be allowed to wander around the office or work area. Not only is this a safety hazard, but the work is very often interrupted to refer customers to the sales staff for assistance.

The nurseryman should plan the layout of the garden center in such a way that important areas can be expanded without encroaching upon others. At some future time he may want to expand the parking lot but may find it impossible because some facility is in the way. However, by careful, thoughtful planning, he can make provisions for future expansion if it becomes desirable.

Structure: Garden center structures, such as the sales area and adjacent lathhouses, must provide the customer with pleasing and relaxing surroundings. The sales area should not be elaborate and expensive unless the nurseryman plans to cater to a wealthy clientele. Many customers may be repelled by such elaborate structures. They naturally get the feeling since the building is expensive, the merchandise is expensive too. The sales area should be of adequate size, well-lighted and painted a pleasing light color. A well-lighted sales area is important especially if the garden center remains open after dark. Light fixtures should be placed high to avoid shadows. Exterior lights placed throughout the garden center complex help reduce theft.

Because the garden center's most important merchandise (trees, shrubs, and plants) are outside the sales building, the nurseryman should try to make the salesroom appear to be an integral part of this structure. Many of these areas are protected from sun and wind by lathhouses. Lathhouses provide partial shade for the growing plants. Plants displayed in partial shade present a more attractive psychological appearance to the customers. Customers can shop in greater comfort when protected from the sun and wind. Table 2 shows different types of coverings for shaded areas and the attributes of each.

TABLE 2

Shade Coverings

Covering Type	Attributes
Snowfence	Lowest cost. Orient the slates north/south for complete shade with movement of the sun.
Saran (plastic/nylon weave)	Will shrink and deteriorate.
Polypropylene (plastic weave)	Will not shrink.
Aluminum	High initial cost. Extremely long lasting.

Growing area: In the growing area most nursery stock is found and displayed in some type of bed or bin. Careful planning, design, placement, and use of aisles, beds, water outlets, and good housekeeping practices will create a more attractive arrangement for customers.

A pleasing or often unusual bed arrangement will add and enhance interest in displays. Locate beds to allow for the shade supporting posts to be along the edge of the bed. Ideal width of the bed is 6 feet. This permits customers to reach the center from either service aisle.

For container stock a bed is usually just a border, while bare root and B & B plants require a heeling-in bin. This bin should be deep enough to cover the exposed root systems. The material used, i.e., sawdust, peat moss or wood shavings, must keep the root system moist and be available at a reasonable cost.

Aisles within the garden center must be so designed as to provide the customer with easy access and view of the merchandise. Wide aisles accommodate two-way traffic, eliminate congestion, and invite customer inspection of the nursery stock. Walkways should allow the customer to circulate throughout the growing area. Dead end aisles are distasteful to some people and do not allow for the natural flow of traffic, creating congestion.

Many types of materials can be used to surface the aisles in a garden center. The most common include concrete, asphalt, sawdust, and gravel. Sawdust is probably the cheapest surface material, but is inclined to be dusty when dry and messy or slushy when wet. Fine gravel has a tendency to become packed down and the aisles can become muddy due to continued water runoff. Perhaps the best materials to surface the aisles are concrete and asphalt. In either case, both should be applied to a crushed rock base. When concrete is used, the surface should be roughened to prevent accidents due to a slippery surface. When the aisles are constructed, provisions must be made for water drainage. Water will accumulate from irrigation or rain and must have someplace to go.

When the garden center is planned, provisions must be made for an adequate supply of quality water. Water is the most critical resource of a nursery. Without a plentiful supply of water the nurseryman would be out of business. The water supply should be centrally located in the nursery and have a large volume output. There must be an ample supply of water available to sustain the nursery during peak usage periods and for heating, if steam or hot water is used. A site may have all the other attributes for a garden center, but will have to be ruled out because it lacks a water supply.

The planning of the water system is also important. Pipes should be large enough to provide the volume of water and pressure needed. It is common error to install pipes that are too small. These pipes may fit the immediate requirements, but may prove to be inadequate if the facility is expanded.

If the nursery must drill its own well, and is not able to tap the main line of a municipality water source, drilling should be completed before nursery structures are built. Drilling for water may be unsuccessful; therefore, the nurseryman will be forced to haul water or find some other source if his buildings are already constructed. In either event, it will be costly.

Good housekeeping of the growing area is a must if the garden center is to do good business. Many customers will be turned back by an unsightly nursery. They may at times assume that the plants are cared for in the same manner. Customers want to purchase quality landscape materials. Therefore, all dead plants should be removed from the growing area and customer view. The entire garden area must be maintained and be clean in appearance. This means periodically dusting shelves, cleaning aisles, etc.

Sales area: The sales area of a garden center is usually an all-weather structure that houses the cash register, the so-called dry lines, such as fertilizers, insecticides, fungicides, seeds, bulbs, handtools and other equipment, and sales personnel.

In some retail nurseries, however, the sales area is open and located near the entrance of the nursery. In any case, the sales area should be landscaped. Landscaping the sales area demonstrates to the customer the shape and growing characteristics of plant material. Since these plant materials are visible to the customer they must be properly maintained at all times.

A lounge area in the garden center provides an area where the customer can relax and also see plants. Many nurseries locate their lounge areas within the growing area by providing the customers with umbrella-covered lawn tables and chairs. Here the customer can relax and observe surrounding merchandise and perhaps enjoy a cold drink or hot cup of coffee. Attractive displays of merchandise that do not need protection from the weather can be set up in these areas. Such items as statuary, lawn furniture, fountains, etc., provide pleasant surroundings for the lounge area. In many nurseries the lounge area is often provided with a children's play area.

In many garden centers the sales area has facilities for meetings. These meetings are usually provided as a public service for local garden clubs and organizations.

It goes without saying that all garden center personnel should be courteous and knowledgeable of the plant material and products in relating information to the customer.

PLANT SELECTION AND CLASSIFICATION

In addition to planning the location and physical layout of a nursery, another main factor that must be considered is the selection of plants to be handled and marketed. Whether starting a wholesale production nursery or retail garden center outlet, the nurseryman must know which plants are adaptable to the area. Factors considered for plant selection include climate, customer preferences, sizes, types and new varieties of plant material. Proper selection of plant materials can be accomplished by the use of temperature zone maps to check the hardiness of the selected plants, discussions with local extension agents, observing established plants in the community, and visiting other nurseries. Wholesale growers must also be familiar with local conditions where the plants are to be marketed.

Climatic Factor

The choice of varieties of plant material to grow is limited by the extreme cold temperatures in both the production and marketing areas. The colder the temperature, the narrower the selection of varieties. To extend the growing season and widen the selection of plant material, nurserymen grow the plants south of the marketing area. This will provide a larger more desirable plant sooner, creating a cost savings in production, which is passed on to the consumer.

Other climatic factors to be considered in addition to low temperatures are light intensity, humidity, wind velocity, altitude effects, and high temperatures. These are the same environmental factors considered for the site selection of the nursery. From a temperature standpoint, plant materials may be suitable, but from the other climatic standpoints, they may be totally unsuitable for production and for the consumer. Nurserymen consider the total environment when choosing plant material for commercial production.

Customer Preference

One mistake nurserymen often make when starting a new nursery is producing or selling plant material they like. The nursery manager must always consider the customer's preference when stocking any merchandise for sale. The customer should be offered a wide choice. Retail nurseries should handle between 50 and 100 different varieties of plants for their selection. Appendix A describes common nursery plants.

Quality material is the prime consideration for the retail nurseryman when buying plant material. The nursery manager must be careful not to overstock any one variety or a slow moving variety. Special orders should be recorded as possible future standard line varieties.

Sizes and Types

Every year requirements for the size and types of plant material change. All new managers starting in the nursery business should select plant material in demand now and in the future. In the past, demand was for large growing plants. This corresponded with the use of large multi-story houses. Now the trend has reverted to more compact, dwarf plant material accentuating low, single level homes.

The three main factors the nurseryman must remember in operating a successful business are:

1. Current design trends constantly change
2. Popular plants vary in each locale
3. Plant material considered "cheap" or inexpensive by the public must be avoided.

"Cheap" plant material is usually handled as a "loss leader", advertised not to make a profit. Varieties commonly considered cheap by the public are privet (Ligustrum spp.), oleander (Nerium oleander), arborvitae (Thuja spp.), mulberry (Morus alba), and pyracantha (Pyracantha spp.).

New Varieties

As in every business, the introduction of new items each year creates a tremendous volume of sales. The nurseryman must always try to introduce new varieties of plant material or provide new uses for established varieties each year for his customers. This material may be obtained as seed or budwood from public institutions, private businesses, and local residents in the area.

Many varieties which produce flowers, berries, or bright-colored foliage are only in demand and sell steadily during one particular time of the year. The nurseryman has to plan the production cycle of these plants in order to sell them in this ornamental phase. Missing this phase will cause a loss in profit because the nurseryman will either sell the plants at a lower price or be forced to hold them over until they are sold or shifted to larger containers.

Each year a few varieties will loose their popularity and must be discontinued. A variety is dropped from sales when it is:

1. Overproduced
2. Uneconomical to produce
3. In low demand

Plant Classification

It is necessary to use botanical names of plants in order to accurately identify them. Common names vary from community to community and it would be very confusing to try to depend upon these names alone for identification. Botanical names are definite and never duplicated; they are used all over the world and are descriptive. The botanical name is in Latin, an international language, and is the same throughout the world.

Most plants have two part names consisting of the genus or family and species or variety. To further identify specific new varieties a third name is attached. Example, Prunus persica is the common peach while the nectarine, a mutation is Prunus persica nectarina, or to designate the blue Italian cypress, Cupressus sempervirens 'Glauca'.

New plants may be patented under the same regulations as any new innovation in other industries. The propagation of this material is regulated by agreement with the patent owner. The naming of a patent variety has been changed to "cv" for "cultivar" by the International Horticultural Congress. Example: The Robin grape is Vitis vinifera cv 'Thornburg's Robin'.

WHOLESALE NURSERY PRODUCTION

At which particular step the nursery operation begins depends upon the management's decision to maximize profits. If it is cheaper to buy liners, small plants, from other producers than to propagate and grow seedling stock, this is the initial step of nursery operation. The primary measure of a nursery's success is its profit. No matter which step of production the nurseryman starts, without competent management, there will be no profit.

The wholesale nursery business is not a single operation of producing plants for sale, but a series of involved steps each efficiently managed to provide the consumer with quality plant material. These steps, when followed efficiently, allow nurserymen to produce plants competitively. Included in these steps are propagation, container selection, production cycle, proper use of tools and equipment, growing media, proper fertilization, correct pruning and transportation.

Propagation

The two most common methods by which plant materials are propagated are rooted cuttings (asexual) and the germination of seed (sexual). To produce nursery stock economically, the nurseryman must use the cheapest and easiest method to reproduce the desired plant (Appendix A).

Propagation of ornamentals by seed encompasses approximately 50% or half of the nursery stock. This mode of reproduction also includes the production of Pyrus, Prunus, and citrus rootstocks. This one particular phase requires a thorough and complete knowledge of seed varieties. Whichever method is used, the nurseryman must utilize the available facilities appropriately and provide good management.

Plant material: The facilities used for propagation of selected varieties are directly influenced by the type of plant; namely, broadleaf and narrowleaf evergreen and deciduous material. The first two, broadleaf and narrowleaf evergreens, are the most important types of cuttings. Broadleaf evergreens have the highest rooting response and percentage when the cuttings are made in the spring of the year. They will respond best in spring and summer. Narrowleaf evergreens root best after undergoing a cold period. They are very slow to root. Cuttings from deciduous plant material are made after all of the leaves are shed and before spring growth initiates.

Regardless of the type of plant material used for cuttings, they should be taken when the carbohydrate/nitrogen (CHO/N) ratio is high. There are direct correlations between the high CHO/N ratio and rooting response. Results are tested by using a petiole analysis.

The size of the business will also determine the simplicity or sophistication of facilities. Smaller nursery operations do not have the capital available to invest in special propagation and growth structures. They must suffice with a greenhouse and/or a number of cold frames.

Management practices: Approved management practices including the use of proper irrigation equipment, growing medias, chemical and environmental controls, and sanitation will result in the maximum rooting and growth response. These management procedures applied correctly will result in a profitable and successful business.

Mist system - Until the cutting is rooted, it needs a film of moisture on it to prevent wilting. This is accomplished with the use of an intermittant spray system. Controls regulating this mist system may be either light or moisture sensitive. Each control is connected by solenoid relay to a time clock or a combination of on/off and spray duration interval clocks. In either installation, a manual by-pass is needed during periods of electrical power outages.

Clean water having a very low soluble salt percentage is used to prevent salt accumulation and damage in the new developing tissue. As a safety factor, root the cuttings under 50% shade to reduce the water and nutrient requirements until the root system has developed satisfactorily.

Growing media - The media to be used should always be sterile, well-aerated, non-toxic, and well-drained. Whatever the media composition, the cheapest available source is used, while maintaining the greatest rooting response. Hard to root varieties very often will have a better rooting percentage if placed in a media with the optimum pH between 5.5 to 7.0.

Using flats for propagation is advantageous over beds. Flats are easier to handle and can be moved to harden-off the cuttings. Disease infestation is virtually eliminated with flats. Should disease occur by change, the flat can be removed immediately and treated; whereas when using beds, all of the material must be treated to prevent loss.

For maximum efficiency, a flat should be filled full to reduce stagnant air and decrease disease infestations. Cuttings are planted shallow, increasing air circulation around the stem, to prevent stem rot of the cuttings. Cuttings are spaced with the leaves touching in order to utilize the most area of the flat. The flat is kept raised off a solid surface, thus improving drainage and allowing excess moisture to run out.

Environmental control - In the propagation structures, the main environmental control factor is temperature. To insure the maximum rooting response, the growing media should be warmer than the atmospheric temperature. This is accomplished with the use of the bottom heat. The optimum temperature range is between 60° and 80°F; with conifers and narrowleaf evergreens 60° to 65°F and broadleaf evergreens 75° to 80°F.

Chemical control - Chemical growth regulators enhance and increase rooting response. To maintain the same high percentage of response while reducing costs, the growth regulator solution is diluted with ethanol. Table 3 shows three application methods of growth regulators.

TABLE 3

Application Methods of Growth Regulators

Type	Concentration (ppm)	Remarks
Concentrated dip	500 to 10,000	Dip cuttings into solution for a few seconds.
Diluted dip	20 to 200	Soak cuttings up to 24 hours in solution.
Powder/Talc	Varies	Wet cutting and dip into concentration. This method wastes excess powder and spreads disease.

Sanitation control - The most essential control in the propagation phase of nursery production is sanitation. The prevention of weed seed germination and disease outbreaks will save material from being discarded or treated, thus reducing production costs. Clean water and a sterile media should always be used. Any material not sterilized should not be used.

Container Selection

Throughout the production cycle, most nurseries will use several types of containers. The selection and value of containers are based upon their influence on cultural practices, cost of production, and cost of marketing. The advantages of container-grown stock are that they have an enclosed root system, are easier to transplant and have a higher survival rate.

Influence of cultural practices: The types of containers influence, to a certain extent, cultural practices involved in nursery stock production. Root growth and soil temperature are influenced by the cultural practices. Both clay and metal containers require more water than the plastic type. Clay pots need more water due to the porosity of clay material, while metal containers are excellent heat conductors contributing to water evaporation from the soil medium. To eliminate any overwatering that may occur, nurserymen should not mix different types of containers within a watering block.

Root growth - Roots grow out and down until forced to change direction. This results in roots curving around in the shape of the pot. Once root tissue develops, they do not straighten out. Root tissues only enlarge causing free space to gradually decrease and eventually girdling the nutrient uptake of the root system. Since roots do not grow into dry areas, a dry portion of the container will also cause this curving effect.

Placement of drainage holes also affects root growth. Holes should be on the side of the container with the bottom of the drain hole flush with the bottom of the container. This will provide drainage of all excess water, should the bottom holes become plugged. Poor drainage will inhibit adequate root growth and increase the probability of disease infestation.

Construction of flats should be designed to provide a free space between the bottom slats of the flat and the rooting bench. This will allow adequate drainage of the flats.

Soil temperature - Soil temperature in a container varies with both its composition and color. Plastic containers insulate the root system better during short temperature changes than metal containers. Metal containers are excellent conductors of heat and cold. During sustained periods of excessive cold, containers should be placed as close as possible to reduce the air space and the circulation of cold air around the vulnerable root system. Root systems are generally more susceptible to freeze damage than the plant's foliage.

A comparison of different colors shows that dark colored containers, black, green, and rust, absorb more heat, often reaching temperatures between 115° and 140°F. These potentially lethal temperatures will inhibit root growth. Light, silvered colored containers and beds oriented with minimum western exposure have the coolest temperatures.

Cost of production: Selection of the containers is influenced not only by the direct cost, but by the efficiency of the operation. Nurserymen must know if the containers can be reused, stored efficiently, and easily handled. Tables 4 and 5 illustrate the advantages of the types of containers for propagation, liners, and salable plants. Plastic containers are lighter in weight, not as strong, and do not transport well when stacked as do metal containers. Aluminum containers are lighter in weight than steel containers, but the initial cost is greater. Also, fertilizers will cause a more rapid deterioration of aluminum than plastic or steel.

TABLE 4

Containers for Propagation

Material	Type	Reusable	Use of Space	Durability	Steam Sterilize
Clay	Pot	Yes	Poor	Good	Yes
Plastic	Pot	Yes	Poor	Good	No
	Trays	Yes	Good	Good	No
Wood	Flat	Yes	Good	Fair	Yes
Metal	Flat	Yes	Good	Good	Yes
Paper	Flat	Limited	Good	Poor	No

(Source: Furuta - Nursery Management Handbook Section 5, University of California, 1969)

TABLE 5

Containers for Liner and Salable Plant Production

Material	Type	Roots penetrate side	Remove to transplant plants	Reusable	Remove to ship plants	Porous side
Clay	pot	no	yes	yes	yes	yes
Plastic	pot	no	yes	yes	no	no
	jointed pot	no	yes	no	no	no
	band	no	yes	yes	no	no
	sleeve	no	yes	yes	no	no
	mesh	yes	no	no	no	yes
Organic matter peat	pot	yes	no	no	no	yes
bagasse	pot	yes	no	no	no	yes
paper	band	no	no	no	no	no
	sleeve	no	yes	no	no	no
	pot	no	yes	no	no	no
wood veneer	band	no	yes	no	no	yes
Metal	pot	no	yes	no	no	no

Pot - side and bottom solid with suitable drainage holes provided; jointed pots - more than one pot joined together; sleeve - only side solid, bottom open, taller than wide; band - only side solid, bottom open, height and width equal; mesh - open weave material.

(Source: Furuta - Nursery Management Handbook Section 5, University of California, 1969)

Cost of marketing: Marketing costs influence container selection. Factors considered for the selection of a container are:

1. Weight. As the weight of the containers increases, transportation costs increase.

2. Limited shipping space. With the containers stacked on one another in shipment, strong containers are needed to prevent crushing of the bottom plants.

3. Attractiveness. Consumers prefer neat appearing green color containers with the height greaten than the width.

Larger containers over 15 gallon size are usually collapsible wooden boxes. Metal drums have been used to a limited degree, but the removal of the plant is difficult for both the consumer and the plant.

There are many different types and styles of containers used by nurserymen. As of now, there is no ideal container. The ideal container should consist of the following characteristics:

1. Be attractive and appealing to the consumer.
2. Be durable and resistant to decay or deterioration.
3. Not inhibit plant growth.
4. Not create soil conditions such as extreme temperature, disease or moisture conditions that inhibit or adversely influence plant growth.
5. Be strong enough to hold together when moved.
6. Be strong enough to allow maximum stacking during shipment.
7. Not add excessive weight.
8. Be attractive in retail displays.
9. Not create any hazard in planting for the consumer.
10. Remove easily from around the plant.
11. Be reusable.

Production Cycle

Most wholesale nurseries either begin their production with propagation or liner operation. Nurserymen either purchase rooted cuttings from other sources or propagate their own. If purchasing cuttings is easier than propagating, the production cycle starts with the liner phase of the cycle. Refer to the section on propagation for the preferred methods of handling cuttings. Other operational phases in the production cycle include the liner, 1-gallon containers, 3 and 5-gallon containers, larger specimens and other methods of production.

Liner production: Liners are small plants, normally rooted cuttings or seedlings, used to line out (plant) in the field or to plant into small containers, 2¼ to 4 inches wide, for growing into larger plants. By using larger pots with good cultural practices, these plants will attain maximum size in the shortest time, producing foliage of sufficient size to start shaping sooner. Advantages for liners in pots over bed grown stock are:

1. Plants have a more complete root system when transplanted.
2. Plants are easier to handle and have a higher survival rate when transplanted.

While the advantages for bed grow liners are:

1. They are cheaper on a cost per unit basis.
2. Larger plants will result.

Once again the type of container to use depends upon cost. Nurserymen must use the cheapest available type of liner. Keep in mind, clay pots are more porous and will not insulate root systems as well as plastic.

Peat pots are for single or one time use only. Since roots grow out of the pot which deteriorates, peat pots are not reusable like plastic. Single usage adds to the cost of reordering new supplies. Another drawback to using peat pots is the time required for transplanting. If transplanting is delayed, the root systems will grow through the pots making them virtually impossible to separate.

Root-bound liners should not be bought if at all possible. When transplanting root-bound liners, several vertical cuts are made into the ball. This enhances new root branching and growth for support.

The most desirable root ball is one in which the roots are well distributed throughout the container. When the plant is lifted, soil will not separate and fall off. Also, roots must not be in the process of wrapping themselves around the soil ball in a tangled mass.

1-gallon container: The usual time for a plant to remain in a 1-gallon container is approximately one year. In the growing beds, spacing of containers has been "can tight", as foliage spread is not as wide as the can. Once plant growth spreads to the edge of the container, usually within six months, spacing is increased to 18 inches on center (OC). With increased labor costs, a nurseryman will find he will save money if initial container spacing is 18 inches OC. The wasted space for the first six months if offset by the high labor costs of moving the containers.

3 and 5-gallon containers: After one year's growth, 1-gallon plants are ready to be shifted into larger containers. In the Eastern half of the United States, they are normally put into 3-gallon containers, but in the West the move is into a 5-gallon container. Production time for salable 3-gallon plants is usually one year. 5-gallon development may take longer, but with a full twelve month growing season growing time is about 12-14 months.

Larger specimens: There are many nurseries dealing only in the production and sale of large specimen plants. These nurseries do not grow any stock, buying either 1-gallon or larger stock, shifting plants into specimen containers, and growing plants to salable size. There are many disadvantages to this type of production. A few are:

1. Growers must be able to buy sufficient 1-gallon plants at a reasonable price.
2. There is always a shortage of demand varieties.
3. Growers cannot introduce new varieties.
4. Nurserymen are dependent upon other nurseries for first quality plants.

Advantages to this type of production are:

1. There is a fast turnover of money.
2. Less labor is required.
3. The nurseryman is not faced with the problems of small container growth.

Other methods: Other methods have been tried in order to save time in producing salable plants. Two methods are the propagation of cuttings directly into both pots and 1-gallon containers. Both techniques require a tremendous amount of greenhouse space until the cuttings have rooted. Another problem is getting large cuttings from stock plants. Regardless of how one propagates and grows plants, the time table is variable. Short production time and high quality plants depend upon:

1. Large-sized liners not pot bound.
2. Quick growing varieties.
3. Suitable environmental conditions.
4. Utilization of approved cultural practices.

Tools and Equipment

The primary purpose for using proper tools and equipment for any job operation is to save time and labor. Before selecting tools, the nurseryman should test all of the choices for ease of operation. Tools and equipment should:

1. Cut production costs.
2. Make labor more productive.
3. Improve quality.

Not all work can be mechanized. There is a need for a certain amount of hand selection and definite need for human judgment to make this selection.

Several different types of equipment are available for wholesale nursery production; namely, metering, mixing, material handling, assembling and controlling the environment. Metering equipment controls the injection of a concentrate at a predetermined flow, while mixers combine and blend together solid material as do shredders. Examples of metering equipment are sprayers, foggers, liquid fertilizer injectors and steam sterilizers.

Material handling equipment includes conveyors, trailers, handcarts, and lifts which carry or move items in a nursery. Usually the only mechanical assembling equipment are the components of the potting and canning operations. These mechanical aids make the labor force more productive and efficient.

Various heating and cooling, frost protection and irrigation equipment are utilized to control the environment around the plant in the nursery.

Use of fertilizer equipment will further demonstrate the different metering and spraying types. The sophistication of equipment depends on the system and capital invested. Regardless of how sophisticated the equipment is, all systems meter the water flow, integrate and inject the fertilizer into the irrigation system. The rate of application must be constant, over a period of time, with the flow of water. The injection ratio is the amount of fertilizer solute per 100 gallons of water. The three major types of injector systems are Venturi suction, Eductor, and Positive Displacement Pump.

Water creates a suction in the Venturi system pulling the solute from the reservior into the irrigation system. The injector ratio ranges from 1:12 to 1:17 changing with the water pressure. This is the most inexpensive system. An example is the Ortho Lawn Sprayer attached to a garden hose.

The Eductor system incorporates a solute tank within a water tank. Water pressure maintained in the outer tank compresses the inner tank forcing the concentrated fertilizer into the system. Selection of the injection ratio (range 1:15 to 1:300) remains constant regardless of the changes in water pressure.

The Positive Displacement Pump is the most efficient, reliable, and expensive system. It is mechanically geared to maintain a constant injector ratio with either fixed or variable selection and will connect to any water main between ½ inch and 6 inches in diameter.

Sprayers are also used to apply fertilizer to foliage. Again, the two types of sprayers are Venturi suction and pressurized tank. The pressurized tank may vary in size from a small hand pump to a large compressor/tank system. The ideal output must be of low volume and low pressure in order to reduce spray drift and any possibility of foliar burning.

Growing Media and Mixes

Plants will grow in many different media which provide basic properties of support, moisture, nutrition, adequate aeration, sterility, and suitable pH level. Regardless of which growing media is used, nurserymen should never use an unamended soil alone. The nurseryman can always add nutrients to an infertile soil to reach optimum fertility; however, the nutrient levels in a high fertility soil cannot be lowered to reach the optimum level.

Support: The media mix should be heavy enough to withstand loading and shipping. Light mixes will not transport easily and will crush under weight.

Moisture holding capacity: Growing media must hold available moisture for use by the plant. The effect of different amendments on the infiltration rate of water is shown in Table 6.

TABLE 6

Infiltration Rates for ½ Inch of Water
in Various Amended Growing Media

Soil Mixture	Time (Min.)
Sandy loam	52
2/3 sandy loam, 1/3 peat moss	39
2/3 sandy loam, 1/3 sawdust	3

The moisture holding capacity of a given soil depends upon its original structure and composition. The use of amendments or additives can alter this capacity. The water holding capacity of a medium will influence the number and frequency of water applications necessary to sustain plant growth.

Nutrition: Nutrition is based upon cation exchange capacity or ability to hold ions for plant use. As illustrated in Table 7, Cation Exchange Capacity, several amendments have higher ion holding capacities than sand. Constant liquid feeding is used when the growing media has low cation capacities. This feeding method results in more growth and a greater increase in the plant's dry weight, than a single feeding per month. Heavier soils with high ion holding capacities can accumulate nutrients and cause damage from excessive fertilizer.

TABLE 7

Cation Exchange Capacity

Soil Type	Cation Exchange Capacity (Milliequivalents/100 g. Dry Wt.)
Sand	0
Vermiculite	20
Peat Moss	14
Redwood Sawdust	3

Aeration: Most amendments improve aeration. Peat moss after a few years will compact and fill existing pore spaces causing drainage to be interrupted. When this occurs, wood shavings can be incorporated into the soil to increase porosity. Clay and silt are poor soils having little pore space and need to be amended.

Sterilization: Sterilizing is a term commonly given to the process of treating soil or similar materials for harmful organisms, weeds, and insects before it is used for sowing seed or for transplanting purposes. If properly done, sterilization should kill weed seeds and soil-borne insects and diseases; thus, the bacteria, fungi, and virus organisms that are potentially harmful to the crop will be eliminated. In addition, it makes heavy soils more granular; greatly improving drainage and aeration. This granulation often results in improved plant growth.

Soil to be sterilized must be loose and easily crumbled so that it can be thoroughly penetrated by heat or chemicals. All lumps should be broken up and heavy trash removed. The soil should be sufficiently moist to permit seed germination. Moist soil should hold its shape when squeezed in the hand. All soil amendments (peat moss, manure, sand, and other compost material) must be added before treating. When using soil fumigants, fertilizers containing ammonia are not added before treatment. Soil fumigation is a method of soil sterilization that employs the use of chemicals. A gas is given off in the fumigation process (refer to Student Reference No. 2, Soil and Other Growing Media, Specialized Curriculum in Ornamental Horticulture).

pH level: Availability of nutrients is dependent upon the media pH. As shown in Figure 5, iron (Fe) is more available in acidic soils with a pH below 7.0 while Calcium (Ca) availability increases in alkaline soils with a pH above 7.0. (See Appendix B for optimum soil pH levels for woody ornamentals.)

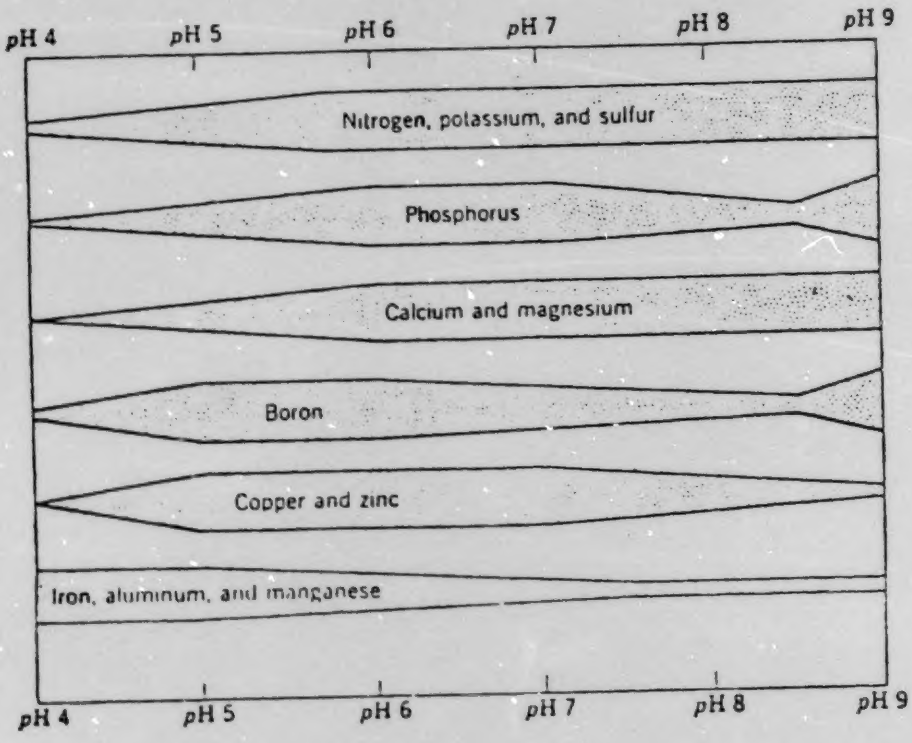


Figure 5. Soil pH Influences the Availability of Plant Nutrients

Physical components: Regardless of which soil mixes are used, they must be reproduced economically. To be desirable, the components of a mix must be:

1. Readily available.
2. Chemically uniform.
3. Able to be sterilized or fumigated.
4. Easily made into a uniform mix.

The comparison of the water-holding and cation exchange capacities of various amendments are shown in Table 8. Manure is not recommended in container production due to the high variability of the salt concentration (approximately 10 percent by weight).

TABLE 8

Physical Components of Amendments

Organic Matter	Water-Holding Capacity	Cation Exchange Capacity	Remarks
Vermiculite	Low	High	Expensive.
Perlite	Low	Low	Expensive; better aeration than vermiculite.
Peat Moss	High	High	Expensive; use only one brand for the same decomposition.
Sawdust	Low	Low	Cheap; may have toxic resins after sterilization. Use the same mill to maintain quality. Nitrogen must be added to aid decomposition.

Fertilization and Fertility

Nutrient requirements vary from plant species to species. Changes in fertility are gradual. Plant growth varies accordingly with the different species. Restrictions for container-grown plants are essentially due to: (1) small soil volumes, (2) limited cation exchange, and (3) limited water. The following fertilization guidelines should be utilized when growing most ornamental plants:

1. Low fertility levels are maintained to prevent root injury during transplanting.
2. Nutrition levels are raised gradually.
3. Optimum levels should be maintained over entire growing season.
4. Fertility levels are reduced when growth slumps during summer and winter seasons.
5. Nurserymen must know the cation exchange capacity of the soil mix.

Plants will show visual symptoms when nutrient levels are either deficient or excessive (refer to Table 9, Nutrient Deficiency Symptoms and Table 10, Nutrient Toxicity Symptoms). When symptoms are visual, growth has already stopped.

There are three application methods for applying fertilizer to plants; namely, dry, liquid, and foliar. As shown in Table 11, labor and equipment requirements vary depending upon the sophistication of the operation. Table 12 illustrates many different formations of fertilizers on the market today, recommended application methods, application rates, and reaction speed.

Today, with the scarcity and often complete unavailability of fertilizers, nurserymen must adjust and utilize available fertilizers to meet their needs. For example, to make 100 pounds of a 10-10-10 fertilizer from ammonium phosphate (16-20-0), potassium sulfate (0-0-50), and ammonium sulfate (21-0-0), the following formula is used:

$$X = \frac{A \times B}{C}$$

whereas: X = Pounds of carrier required.
A = Pounds of mixed fertilizer.
B = Percentage of element desired.
C = Percent of element in carrier.

By substituting the values in the equation, it can be seen that 50 pounds of ammonium phosphate, 20 pounds of potassium sulfate, and 9½ pounds of ammonium sulfate are required to produce 100 pounds of a 10-10-10 complete fertilizer.

TABLE 9

Nutrient Deficiency Symptoms

Nutrient Element (Symbol)	Symptoms
Nitrogen (N)	Small leaves, short, small, thin growth. Uniform yellowing of leaves, becoming red in severe cases. Leaf abscission occurs, beginning with older leaves.
Phosphorus (P)	Bronze to red coloration of dull-green leaves; shoots short and thin.
Potassium (K)	On older leaves, marginal chlorosis followed by marginal necrosis.
Calcium (Ca)	Death of the terminal bud, often preceded by chlorosis of the young foliage. Leaves may be distorted with the tip hooked back. Root system damaged first, usually as death of the root tips.
Magnesium (Mg)	Interveinal chlorosis on the older foliage, followed by interveinal necrosis.
Boron (B)	Distortion or thickening, or both, of the young terminal foliage. Some chlorotic spots may appear on the foliage. Terminal bud ceases development and lateral growth begins. Lateral growth soon goes through same cycle described.
Sulfur (S)	Uniform yellowing of new and young foliage.
Iron (Fe)	Interveinal chlorosis of the young foliage, followed by bleaching of leaf color to cream or white.
Copper (Cu)	Necrosis and white mottling of newer foliage. May result in small, linear, distorted leaves. Shoots die back.
Manganese (Mn)	Yellow chlorosis of foliage.
Molybdenum (Mo)	Linear leaf does not fully expand; color often bluish-green, chlorosis and necrosis also present.
Zinc (Zn)	Small, narrow leaves in a rosette-like whorl.

(Source: Furuta - Nursery Management Handbook
Section 7. University of California, 1969)

TABLE 10

Nutrient Toxicity Symptoms

Nutrient Element (Symbol)	Symptoms
Nitrogen (N)	In some plants (example: azalea), excess nitrates result in iron deficiency symptoms due to poor metabolism of iron. Ammonia toxicity results in injury and death of the root system. Yellowing of new foliage may appear.
Phosphorus (P)	Variable responses may appear, including iron or zinc deficiency due to tie-up in the soil. Chlorosis on the older foliage may appear. Chlorotic areas are irregular as contrasted to regular symptoms of potassium and magnesium deficiencies.
Boron (B)	On older leaves, chlorosis followed by necrosis at the tips of the serrations or irregularly along the leaf margin. Abscission of the foliage usually follows.
Lithium (Li)	Irregular marginal chlorosis and necrosis on the older foliage.
Manganese (Mn)	Chlorosis and yellowing of the new foliage may appear following steam sterilization due to the action of temperature above 105°F on release of free manganese in the soil. Also may appear due to highly acid conditions or poor aeration.
Aluminum (Al)	Death of the plant, usually preceded by variable chlorosis of the foliage. Usually results from highly acid conditions. Pink hydrangea flowers become blue when aluminum is present.

(Source: Furuta - Nursery Management Handbook Section 7, University of California, 1969)

TABLE 11

Fertilizer Application Methods

Procedure	Description	Manpower Needs	Equipment of Machinery Needs
Dry Applications	Measured amounts of fertilizer in dry form placed in each container at periodic intervals.	High	Low
Liquid Applications			
-periodic	Measured amounts of fertilizer dissolved in water and applied at periodic intervals.	Low to high, depending on irrigation system.	Low to high, depending on irrigation system.
-constant	Measured amounts of fertilizer applied to each irrigation.	Low	High
Foliar Applications	Fertilizer solution sprayed on foliage at frequent intervals.	Medium	High

(Source: Furuta - Nursery Management Handbook Section 2, University of California, 1969)

TABLE 12

Fertilizers and Their Uses

Name and Formula of Material	Analysis		Application Method[1]					Application Rate				Reaction Speed	Solubility	Effect[2] or Soil Acidity	Notes
	N-P-K	Others	Preplant Incorp.	Dry	Postplant Supplement Liquid	Postplant Supplement Constant	Foliar	Preplant Incorp.	Dry	Postplant Supplement Liquid	Foliar				
								lbs. per cu. yard	ozs. per gal. can	ozs. per gal.	ozs. per gal.		lbs. per 100 gal.		
Nitrogenous Materials															
Ammonium Chloride NH_4Cl	25-0-0	0	0	+	++	++	0	0	0.01	0.33	0	Rapid	100	Very Acid	Continued use may result in excess chloride ions.
Ammonium Nitrate NH_4NO_3	33.5-0-0	0	+	+	++	++	0	0.25	0.005	0.20	0	Rapid	150	Acid	
Ammonium Phosphate (di) $(NH_4)_2HPO_4$	21-53-0	0	+	+	++	++	0	0.25	0.005	0.20	0	Rapid	120	Acid	
Ammonium Phosphate (mono) $NH_4H_2PO_4$	11-48-0	1.4% Ca 2.6% S	+	+	++	++	0	0.50	0.01	0.33	0	Rapid	120	Acid	
Ammonium Sulfate $(NH_4)_2SO_4$	20-0-0	24% S	0	+	++	++	0	0	0.02	0.50	0	Rapid	135	Very Acid	Continued use may result in excess sulfate ions.
Calcium Nitrate $Ca(NO_3)_2$	15-0-0	37% Ca	+	++	++	++	0	0.25	0.02	0.50	0	Rapid	180	Basic	
Sodium Nitrate $NaNO_3$	16-0-0	0	0	++	++	++	0	0	0.02	0.50	0	Rapid	170	Basic	May result in excess sodium in soil.
Urea $CO(NH_2)_2$	45-0-0	0	0	+	++	++	++	0	0.005	0.25	1.0	Rapid	115	Acid	

TABLE 12 (continued)

Name and Formula of Material	Analysis		Application Method[1]					Application Rate				Reaction Speed	Solubility	Effect[2] on Soil Acidity	Notes
	N-P-K	Others	Preplant Incorp.	Postplant Supplement Dry	Postplant Supplement Liquid	Postplant Supplement Constant	Foliar	Preplant Incorp.	Postplant Supplement Dry	Postplant Supplement Liquid	Foliar				
								lbs. per cu. yard	ozs. per gal. can	ozs. per gal.	ozs. per gal.		lbs. per 100 gal.		
Urea-Formaldehyde	38-0-0	0	++	++	++	0	0	1.33	0.10	1.00	0	Slow	Slightly	Slightly Acid	Slow release fertilizer. Liquid application as a slurry rather than solution.
IBDU (Isobutylidene Diurea)	31-0-0	0	++	++	++	0	0	1.60	0.10	1.00	0	Slow	0.8	0	Liquid application as a slurry rather than solution.
Phosphate Materials															
Superphosphate $CaH_4(PO_4)_2$	0-20-0	18% Ca 12% S	++	++	0	0	0	5.0	0.10	0	0	Slow	Slightly	Neutral	
Treble Phosphate $CaH_4(PO_4)_2$	0-42-0	12% Ca	+	+	0	0	0	2.0	0.05	0	0	Medium	Moderate	Neutral	
Phosphoric Acid H_3PO_4	0-52-0	0	0	0	++	++	0	0	0	0.50	0	Rapid	Very Soluble	Very Acid	
Potassium Materials															
Potassium Chloride KCl	0-0-62	0	++	+	++	++	0	0.5	0.01	0.20	0	Rapid	115	Neutral	Continued use may result in excess chloride ions.
Potassium Nitrate KNO_3	13-0-44	0	++	+	++	++	0	0.5	0.01	0.20	0	Rapid	120	Basic	
Potassium Sulfate K_2SO_4	0-0-53	18% S	++	+	++	++	0	0.5	0.01	0.20	0	Rapid	70	Neutral	Continued use may result in excess sulfate ions.

TABLE 12 (continued)

Name and Formula of Material	Analysis		Application Method[1]					Application Rate				Reaction Speed	Solubility	Effect[2] on Soil Acidity	Notes
	N-P-K	Others	Preplant Incorp.	Dry	Postplant Supplement Liquid	Constant	Foliar	Preplant Incorp.	Postplant Supplement Dry	Postplant Supplement Liquid	Foliar				
								lbs. per cu. yard	ozs. per gal. can	ozs. per gal.	ozs. per gal.		lbs. per 100 gal.		
Complete Mixtures															
Soluble (examples)	12-12-12	0	0	0	++	++		0	0	0.33	See Note	Rapid	Very Soluble	Various	Some combinations have been developed for foliar feeding. Follow manufacturer's recommendations.
	20-20-20	0	0	0	++	++		0	0	0.25	See Note	Rapid	Very Soluble	Various	
	25-10-10	0	0	0	++	++		0	0	0.25	See Note	Rapid	Very Soluble	Various	
Dry (examples)	10-10-10	0	+	++	0	0	0	0.5	0.05	0	0	Various	Slightly	Various	
	5-10-5	0	+	++	0	0	0	0.5	0.05	0	0	Various	Moderate	Various	
Organic	Various	0	++	++	++	0	0	0.5	0.05	0.50	0	Various	Various	Various	Liquid application as a slurry.
MagAmp-Magnesium Ammonium Phosphate	7-40-6	0	++	++	0	0	0	7.1	0.10	0	0	Slow	Slightly	0	Slow release fertilizer. Phosphorus and magnesium content excessive for some plants.
Osmocote	14-14-14	0	++	++	0	0	0	3.6	0.10	0	0	Slow	Slightly	Various	Slow release fertilizer. Available in various formulations.
	18-9-9	0	++	++	0	0	0	2.8	0.10	0	0	Slow	Slightly	Various	

TABLE 12 (continued)

Name and Formula of Material	Analysis N-P-K	Analysis Others	Application Method[1] Preplant Incorp.	Application Method[1] Postplant Supplement Dry	Application Method[1] Postplant Supplement Liquid	Application Method[1] Postplant Supplement Constant	Application Method[1] Foliar	Application Rate Preplant Incorp.	Application Rate Postplant Supplement Dry	Application Rate Postplant Supplement Liquid	Application Rate Foliar	Reaction Speed	Solubility	Effect[2] on Soil Acidity	Notes
								lbs. per cu. yard	ozs. per gal. can	ozs. per gal.	ozs. per gal.		lbs. per 100 gal.		
Miscellaneous Fertilizers															
Magnesium Sulfate $MgSO_4$-$7H_2O$	0	10% Mg	+	+	++	++	++	0.25	0.01	0.20	1.6	Rapid	Soluble	Neutral	
Magnesium Nitrate $Mg(NO_3)_2$-$6H_2O$	0	9.5% Mg	0	0	++	++	++	0	0	1.6	1.6	Rapid	Soluble	0	Formulate by using equal weights of calcium, nitrate and magnesium sulfate.
Gypsum $CaSO_4$-$2H_2O$	0	23% Ca	++	++		0	0	1.0	0.05	0.20	0	Medium	0	Neutral	Liquid application as a slurry.
Dried Blood	12-0-0	0	0	+		0	0	0	0.02	0.02	0	Medium	Insoluble	Acid	Liquid application as a slurry.
Micronutrients															
Manganese Sulfate $MnSO_4$	0	28% Mn	++	0	0	0	++	0.05	0	0	0.16	Rapid	Soluble	0	
Boric Acid H_3BO_3	0	17% B	0	0	++	0	++	0	0.16	0	0.16	Rapid	Soluble	0	
Copper Sulfate	0	25% Cu	++	0	0	0	++	0.15	0	0	0.008	Rapid	Soluble	0	
Iron Sulfate $FeSO_4$-$7H_2O$	0	20% Fe	++	++	0	0	++	0.10	0.01	0	0.16	Rapid	Soluble	Very Acid	
Iron Chelates	0	Various % of Fe	++	++	++	0	++	0.10	0.01	0.80	0.16	Rapid	Soluble	0	Various forms available. Situation dictates particular type to use.

TABLE 12 (continued)

Name and Formula of Material	Analysis		Application Method[1]					Application Rate				Reaction Speed	Solubility	Effect[2] on Soil Acidity	Notes
	N-P-K	Others	Preplant Incorp.	Dry	Postplant Supplement Liquid	Constant	Foliar	Preplant Incorp.	Dry	Postplant Supplement Liquid	Foliar				
								lbs. per cu. yard	ozs. per gal. can	ozs. per gal.	ozs. per gal.		lbs. per 100 gal.		
Micro-nutrients															
Ammonium Molybdate $(NH_4)_6Mo_7O_{24}$-$4H_2O$	0	53% Mo	0	0	0	0	++	0	0	0	0.15	Rapid	Soluble	0	
Zinc Sulfate $ZnSO_4$-$7H_2O$	0	36.4% Zn	++	++	0	0	++	0.10	0.01	0	0.30	Rapid	Soluble	0	
Zinc Chelate	0	14% Zn	++	++	++	0	++	0.10	0.01	0.80	0.30	Rapid	Soluble	0	
Copper Chelate	0	13% Cu	++	0	0	0	+	0.05	0	0	0.10	Rapid	Soluble	0	
Manganese Chelate	0	12% Mn	++	0	0	0	++	0.10	0	0	0.30	Rapid	Soluble	0	

---

[1] 0 = do not use; + = use with caution; ++ = safe application method.

[2] Approximate conversion to pounds of calcium carbonate needed to neutralize 1 ton -- slighty acid = 0 to 50 lbs.; acid = 50 to 100 lbs.; very acid = over 100 lbs.

Sample Calculations:

$X = \frac{100 \times 10}{20}$ = 50 pounds of ammonium phosphate required for 10 pounds of phosphoric acid. With this, 8 pounds of N are provided (50 x .16 = 8).

In the same manner potash (K_2O) and additional nitrogen (N) are figured.

$X = \frac{100 \times 10}{50}$ = 20 pounds of potassium sulfate required.

$X = \frac{100 \times 2}{21}$ = 9½ pounds of ammonium sulfate required for the additional N.

By adding 20½ pounds of filler (sand) or physical conditioner to the above components, a 100 pound mixture of 10-10-10 grade is obtained.

Pruning and Shaping

Pruning is the process of making a plant conform to a desired shape or form. Pruning can be eliminated by proper selection of plants for the desired size and shape. Reasons for pruning are mainly safety, appearance, and the plant's health. Pruning for safety usually results from planting the wrong species.

When transplanting, root pruning is essential to reduce any root-bound effect in container grown-stock. Also, root pruning is accomplished when bare root and B & B stock are dug and graded. For each one inch of trunk diameter, one foot of root ball is required for B & B stock. Top pruning of bare root and B & B stock is always a necessity to keep top foliage in proportion with root systems.

Time of season for pruning will depend upon the size and number of branches to be removed. Small liners, 1-gallon container stock, and any specimens requiring a small amount of removal may be pruned anytime during the year. Nurserymen should start shaping plant material in the liner stage of production, thus eliminating pruning problems before plants grow too large. For removal of very large branches, pruning is accomplished during the dormant period of growth.

Transportation

Utmost care should be taken in loading nursery stock to insure its arrival in good condition at the destination. Dealing with a reliable, established trucking firm will insure arrival of the plants in good condition.

Trucks are limited by law as to the size load they can carry. The load should be evenly distributed over all axles of the truck or semi. If more than one delivery is made, each stop is allocated a percentage of space according to weight. Orders are separated by cardboard or kraft paper to prevent a mix-up in delivery. Periodically, each size container is weighed to determine the average weight, so trucks are accurately loaded and not overloaded.

In loading a truck, safe stacking of plants is required. Plants are stacked tightly to prevent any side shifting which would result in severe damage to the plants. All containers are leaned forward creating a triangle with the front wall and floor of the trailer; thus preventing plants from falling backwards when going up hills or during rapid acceleration.

The next row of plants is placed on top of the first row, in between plants and with the weight resting on container edges below. Foliage of most plants may be compressed some without any damage, if the stack is tight. Tender, delicate, and brittle branched plants are placed at the top. These plants may also be wrapped with a protective liner to ensure arrival in good condition. Do not leave any holes in the layers of plants. The stack should appear to be a solid wall of plants.

To prevent leaning rows of plants from slipping on the trailer floor, wooden strips are placed under the first row of containers acting as a wedge, similar to a door stop. The last vertical row is also braced to prevent containers from falling out when trailer doors are opened for unloading. Height of the stack is dependent upon:

1. Physical dimensions of the truck or trailer body.
2. Load weight evenly distributed over all of the axles.
3. Size and weight of the plants.
4. Number and weight of each delivery order.

During hot weather, trailers should be loaded in the afternoon, enabling evening transport during cool night hours for delivery the next day. If loading is done in the morning, plants will be inside trucks during the hottest part of the day. Plants are shipped in enclosed trailers to reduce sun and wind damage to the foliage.

RETAIL GARDEN CENTER NURSERY

Generally, the first encounter the general public has with ornamentals is in the retail nursery or garden center. To be successful nurserymen rely upon repeat business. They will have to be completely familiar with all plants, their care, climatic extremes, area soil problems, and all of the accessory products; i.e., soil conditioners, herbicides, insecticides, potting soils, and many others. Information must be accurate and truthful to the customer.

Table 13 illustrates the four types of retail nursery outlets: self-service, discount, department store and private nursery. Each type of nursery serves different clientele and buying needs. An example of a self-service outlet is a food or hardware store relying on impulse buying of the customer for lower quality plants with an inexpensive price. Discount firms rely heavily on "loss leader" advertising to induce people into the nursery. Major chain operations increase nursery sales with credit usage and offering excellent replacement guarantees. Private nurseries usually cater to a more selective, affluent clientele offering complete landscaping and maintenance services.

TABLE 13

Selected Characteristics Related to Nursery Classes

Nursery Class	Quality Plant Material	Selection	Personnel Knowledge	Price	Remarks
Self-service	Poor	Limited	None	Inexpensive	
Discount	Good	Good	Usually Manager only	Moderate	Very well advertised.
Major Department Store	Good	Adequate	Questionable	Moderate	Credit sales increase volume sales. Excellent guarantee.
Private	Good	Excellent	All	High	Good reputation, landscaping services offered.

Retail Handling

Proper handling and display of nursery stock is extremely important to nurserymen. All displays should be oriented to assist customers in selecting quality nursery stock. Nurserymen must be able to display properly: bare root, B & B, container-grown stock, bedding and foliage plants, bulbs, and, in many instances, turf sod and/or stolons.

Garden centers must be ready to display B & B and bare root material when it arrives from the wholesaler. This stock must be kept moist to prevent the root system from drying out. To do this, display bins should be deep enough to completely cover the roots with either peat moss or sawdust while enabling easy plant removal. Different varieties should be displayed by shape and conformation. B & B plants must be moved by the soil ball, so as to prevent separation of the soil from around the root system. Excessive handling should be avoided, to reduce the possibility of scaffold breakage. When warm weather initiates growth, all stock should be sold, discarded, or "canned" for sale in containers.

Container-grown stock is easier to handle and display than B & B or bare root material. With root systems completely enclosed, container specimens may be displayed in almost any situation accentuating the plant's shape and conformation. This enables the customer to actually visualize the setting.

A retail nursery should carry a wide selection of bedding and potted plants, vegetable transplants, bulbs and turf - all must be available in season. Operators should be familiar with the different species and varieties for each season. Table 14 lists the varieties best suited for different seasons. For greatest profit, only quality items should be sold, insuring customer satisfaction. Items not looking their best, or bulbs sprouting, should be removed and discarded.

A line of related items for plant care is commonly sold as a convenience to customers and to level out income between planting seasons. Items carried include fertilizer, soil conditioners, potting soil, pesticides, garden tools and accessories. Some garden centers also carry large power equipment, storage sheds and Christmas merchandise. The market for such items must be determined prior to capital investment. Any serious mistake could result in a disastrous loss.

Pricing and Labeling

There is no satisfactory formula for pricing nursery stock. Except for fair trade hardware or pre-priced items, nurserymen are on their own in determining selling prices. Most beginning operators set prices too low. This is a serious error, as customers want low prices and resent price increases.

TABLE 14

Varieties of Flowers, Vegetables, Bulbs, and Turf Suited for Warm and Cool Seasons Under 2,500 Feet Elevation

Warm Season (Summer)	Cool Season (Winter)
Annual Flowers	
Celosia	Calendula
Marigold	Lobelia
Portulaca	Pansy
Salvia	Petunia
Verbina	Poppy
Vinca rosea	Snapdragon
Zinnia	Stock
Perennial Flowers	
Chrysanthemum	Carnation
Gaillardia	Dianthus
Geranium	Shasta Daisy
Vinca major	Violet
Vegetables	
Beans	Broccoli
Corn (sweet)	Cabbage
Cucumber	Carrot
Eggplant	Lettuce
Melons	Onion
Pepper	Pea
Pumpkin	Potato
Squash	Radish
Tomato	Spinach
Bulbs	
Caladium	Crocus
Canna	Daffodil
Dahlia	Hyacinth
Gladiola	Tulip
Lily	
Turfgrass	
Bermuda	Bent
Tif hybrids	Poa sp. (bluegrass)
	Rye

Most people do not understand the meaning of markup. One hundred percent markup is impossible. If an item is bought for \$1.00 and sold for \$2.00, the markup is 50 percent, not 100 percent. Markup is figured on the selling price, not cost. The formula for determining markup is given below:

$$\text{Percent Markup} = \frac{\text{sales price} - \text{cost}}{\text{sales price}}$$

A successful nursery must make a profit. Nurserymen must consider all costs such as rent, utilities, salaries, taxes, insurance, cost of replacement stock, and advertising and promotion in determining the selling price. Markup varies with the items being sold. Deciduous stock is commonly marked up 75 percent; B & B and container-grown plants, 66 percent; while dry goods and hardward are marked up 40 percent. Discounting price to increase sales lowers the profit margin per item and increases the work required to maintain this margin before prices were lowered. Garden centers offering high quality plants, courteous, well-informed personnel, and a clean place with adequate parking will have little competition from discount firms.

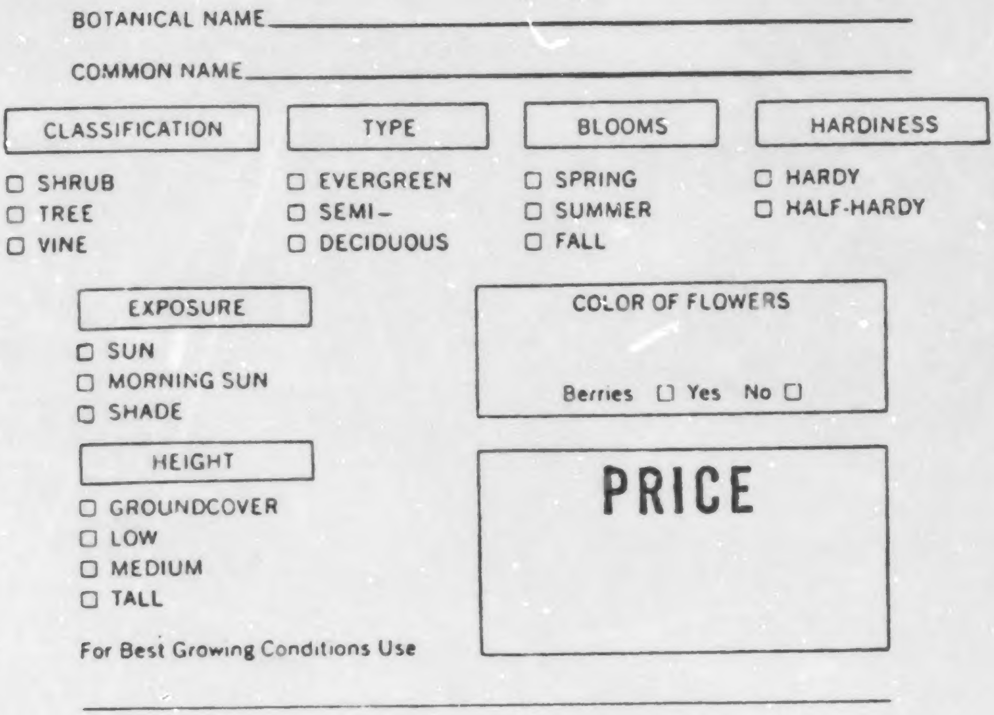
Labeling each species with the name and price will save time for both the customer and salesman. Any information including a photograph showing the plant's growing habit should be on the label (see Figure 6). Labels should be clear, legible, and placed in the center of the species in full customer view.

Sales

Many techniques are used to increase nursery sales. Successful nurserymen realize that excellent customer relations, courteous personnel, and general goodwill is needed to have a thriving business. To be successful, nurserymen must:

1. Enjoy what they are doing.
2. Be informed about plant stock, growing conditions and environment factors.
3. Listen to customers and their problems.
4. Be able to say, "I don't know", rather than bluffing answers to customers.
5. Sell related items, while not overselling customers.

Providing customers with information, written planting instructions, and plant guarantees not only builds goodwill, but creates traffic, bringing prospective buyers to the nursery. Anything provided for the customer's benefit, such as problem clinics or seasonal demonstrations, projects a positive awareness and increases customer confidence in the nurseryman.



BOTANICAL NAME ____________________

COMMON NAME ____________________

CLASSIFICATION
☐ SHRUB
☐ TREE
☐ VINE

TYPE
☐ EVERGREEN
☐ SEMI–
☐ DECIDUOUS

BLOOMS
☐ SPRING
☐ SUMMER
☐ FALL

HARDINESS
☐ HARDY
☐ HALF-HARDY

EXPOSURE
☐ SUN
☐ MORNING SUN
☐ SHADE

HEIGHT
☐ GROUNDCOVER
☐ LOW
☐ MEDIUM
☐ TALL

COLOR OF FLOWERS

Berries ☐ Yes No ☐

PRICE

For Best Growing Conditions Use

____

Figure 6. Nursery Plant Label
(Courtesy: Plant World Nurseries, Tucson, Arizona)

Sales are often increased by providing a complete landscaping service. The desire to create beautiful surroundings with plants is universal. Many customers not only want the installation service, but any required maintenance as well. For the do-it-yourselfer, nurserymen need only to provide help in planning and selecting plants and materials needed for the job. Landscaping customers usually become steady customers, seeking advice and referring their friends to the nursery.

Landscaping services not only increase the income of the nursery, but insure income during slow periods. Since planting can be carried on all summer, work is scheduled to fully utilize personnel. This eliminates laying off personnel and provided work for trained experienced labor.

WATERING AND IRRIGATION

Watering is the most mismanaged operation in the nursery. Not only is the frequency often mishandled, but the amount of water given the plant is either excessive or inadequate. Factors determining frequency and amount of irrigation are:

1. Time of year
2. Soil mix
3. Size of plant
4. Variety and season of growth, whether actively growing or dormant
5. Temperature and humidity

Container-grown stock presents a unique watering problem with each plant in an individual container. More water must be applied more frequently because of limited soil volume. Any water applied should be spread evenly over the surface to moisten the entire soil mass for uniform root uptake (see Figure 7). Whether overhead sprinkling or an individual container system is used, water must get into the containers.

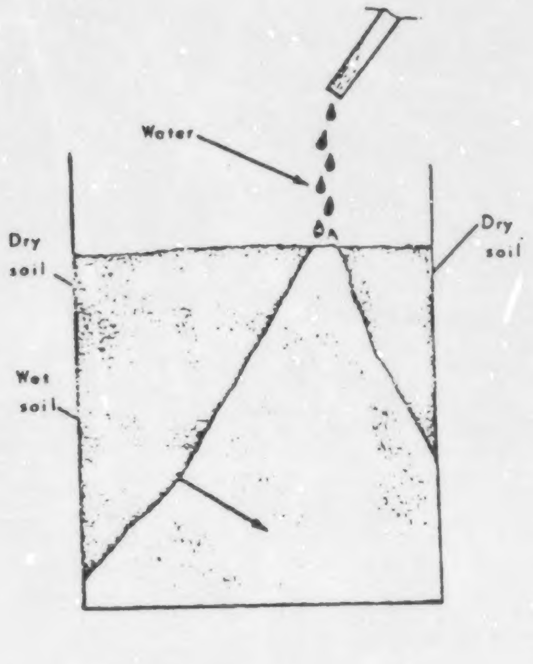


Figure 7. Lateral Flow of Water

(Source: Furuta - Nursery Management Handbook Section 8, University of California, 1969)

Two methods of measuring moisture status and the interval between watering include the use of the tensiometer and weighing the growing container. Either system can be connected to a solenoid relay system for automatic watering. Indirectly, irrigation interval can be measured by light energy units or by an atmometer measuring evaporation. Both indirect methods are effective and expensive to install. They must be calibrated for each specific location.

Irrigation Systems

Many different types of irrigation systems are used for applying water to containers. Most have been adapted from equipment developed for lawn or agricultural irrigation. Three common systems are individual container, subirrigation, and overhead sprinkling.

Individual container or spaghetti: The spaghetti system is a series of small plastic tubes connected to a main water line or lateral with each tube placed in a container (see Figure 8). Water must be distributed over the entire soil surface to insure leaching of any accumulation of salts. These systems require more labor in connecting and disconnecting tubing each time containers are handled.

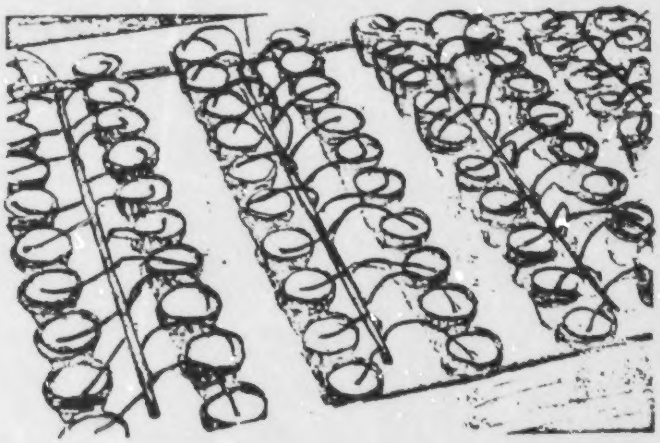


Figure 8. Spaghetti Irrigation System
(Courtesy: Brighton By-Products Co., New Brighton, PA)

Each tube should be the same length to insure that an equal amount of water is delivered from each tube. Constant checking and maintenance is needed to keep tubes from plugging, leaking or breaking. Plastic tubes become brittle with age and must be replaced periodically.

Subirrigation: Subirrigation provides water and nutrients to plants by capillary action. This method is used only where water salinity is not a problem. If water with excess salt is used, evaporation of water from the soil's surface can leave salt deposits which are injurious to plants. This method is used on liners and other small pots (see Figure 9).

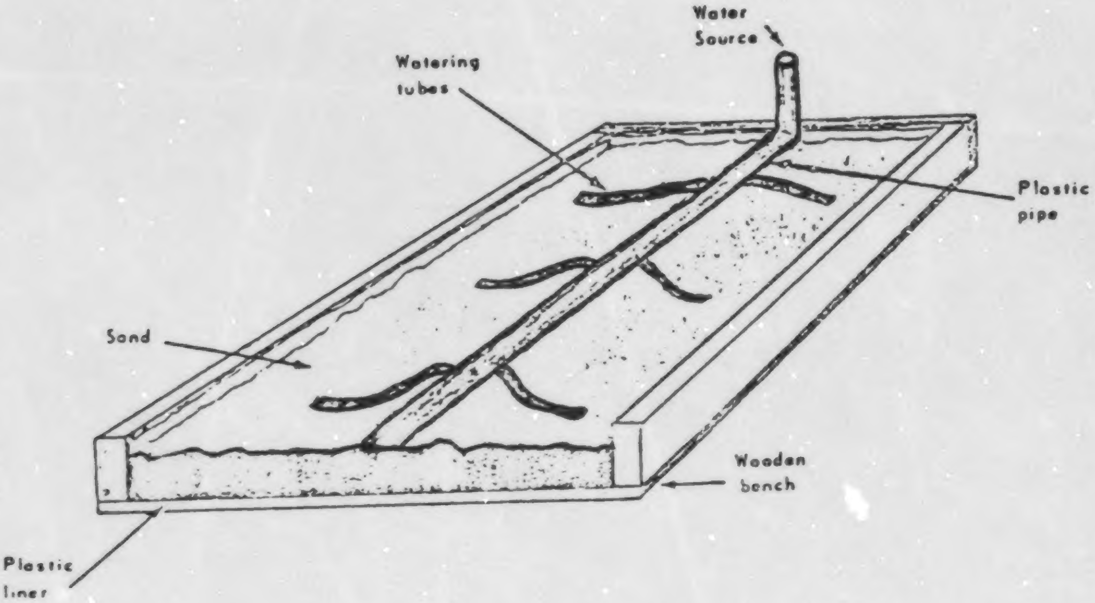


Figure 9. Subirrigation

(Source: Furuta - Nursery Management Handbook Section 8, University of California, 1969)

Overhead sprinkling: Designed originally for lawn irrigation, fixed spray heads are used to irrigate plants ranging in size from liners through 2-gallon containers. Various spray patterns are available; i.e., square, full circle, rectangular, and part circle. Spray heads are usually spaced with a 50 to 75 percent overlap of each sprinkler. This insures an even amount of water distributed over the entire surface (see Figure 10). The quantity of sprinkler spray heads needed for full coverage depends upon: (1) area to be covered, (2) size of sprinkler and nozzle, and (3) water pressure.

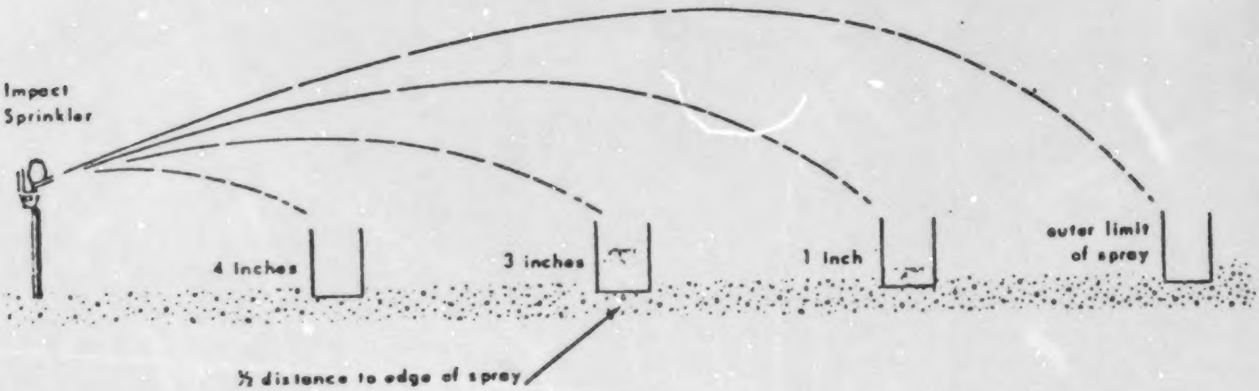


Figure 10. Water Distribution
(Source: Furuta - Nursery Management Handbook
Section 8, University of California, 1969)

Rotating impact spray heads provide the best coverage. Rotation is caused by the movement of the impact arm in and out of the water stream. All models have interchangeable nozzles and some even have baffles to break up the spray.

Some growers irrigate larger plants by this method, but actual water entering containers is low. Foliage growth increases water runoff, as containers remain the same size while plants grow and water requirements increase. Spaghetti systems should be used on 5-gallon and larger containers.

Penetrating the foliage can be achieved by increasing the application rate of water. The increased rate results in larger water droplets, less wind drift, and higher costs. Another advantage of overhead sprinkler usage is the reducing of mites and aphids by the water droplets knocking them off the leaves.

Water Supply

Container plants require from 5 to 8 acre-feet of water during the year. Any source may be used depending upon quality and ability to leach excess salts. To maintain the highest quality water, samples should be analyzed throughout the year. The more sales contained in the water, the more frequent the applications. Excess water can be applied to insure leaching.

Irrigation water may be improved for certain high-value crops. These treatments are usually limited to acidification of deionization. Sulfuric acid is used to change the pH to an acid range. Such treatment will not change the total salt concentration, only the pH. Deionization removes some of the salts from the water. Calcium is removed easier than sodium, while boron is not removed at all. This treated water is extremely corrosive to metal and often creates a copper toxicity problem in the soil medium.

Water from water softeners is not recommended for irrigation. Sodium ions replace calcium and magnesium ions causing a breakdown in soil structure, reducing water penetration, and aeration. Sodium also is toxic to certain plants.

System Design

Once a system has been properly designed, any change in the number of nozzles will result in uneven water distribution. Over-designing a system is expensive, while under-designing results in insufficient coverage. The placement pattern of both nozzles and containers must be known in order to insure the maximum amount of water in the container.

Since containers only occupy a portion of the area, only a portion of the water ever reaches the plant. Spacing of containers is directly related to the total surface area covered. A triangular pattern is preferred over a square arrangement, as less area is needed for the same amount of containers. If the containers are not spaced, triangular placement covers 91 percent of the surface area compared to only 79 percent for square placement. This is magnified even greater with 2 inch spacings; 51 percent of the area is covered with a triangle arrangement, while square placing results in only 44 percent coverage.

Nozzles must be uniformly spaced for adequate coverage. As normal spacing allows for 50 to 75 percent spray overlap, wind will increase this overlap. A closer spacing is used with a reduced discharge rate to maintain the same precipitation rate. For winds above 8 miles per hour, spray overlap is increased to 70 percent by placing nozzles closer together. Remember, water must get into containers before plants are able to utilize it.

APPENDIX A

Taken From the Certified Nurseryman's Manual

Plant Names

A nursery salesperson must be able to identify plants by scientific names. Consider the confusion when the common name cedar is applied to plants that include arborvitae, cedar, cypress, false cypress and junipers.

The American Joint Committee on Horticultural Nomenclature has adopted 'Standardized Plant Names', a dictionary of plant names. In this book, every plant is listed with at least two names. The first is the name of the genus to which the plant belongs. The second word is the name of the species. In addition, each plant has one or more common names.

Pinus contorta is the botanical name of the Shore Pine found on the Pacific Coast. It is known by that name the world over. It has other common names such as Contorted Pine, Coast Pine and Lodgepole Pine. Genus names are always capitalized and species names are not, even if they are derived from proper names.

Giving plants a genus and species name was credited to a Swedish botanist, Linnaeus, 1707-1778. He was appalled at the confusion of common names in his day, and sought to give every plant a name that could be used any place in the world. This system of naming plants is called the binomial system of nomenclature. It is in Latin, a language that does not change.

Within a species, a subgroup may be different enough in appearance from the remaining members of the species to be called a botanical variety. An example of this would be *Taxus baccata var. fastigiata*, which is Irish Yew, a botanical variety of the English Yew, *Taxus baccata*.

The International Code of Nomenclature for Cultivated Plants recognizes a special category, the cultivar (cultivated variety of old horticultural variety), which designates a special group of individuals, significant for the purposes of agriculture, forestry, or horticulture, and which retain their distinguishing features when reproduced. In writing the name of such a plant, the cultivar name is written in the common language and is set off by single quotation marks. For example: *Gleditsia triacanthos* 'Sunburst', the 'Sunburst' Honey Locust or *Juniperus sabina* 'Tamariscifolia', the Tam Juniper.

It is especially important for the retail nursery salesperson to know the correct botanical and accepted common names of the plants he is selling, not only so he can communicate, but also because of the fact that in 1972 and 1973 the State of Washington Department of Agriculture set down requirements that all non-herbaceous ornamental plants be properly labeled when offered for resale. Uniform labeling throughout the nursery trade will not only comply with the law but will also aid the customer.

In practice, proper plant names (botanical names) are more helpful to the nurseryman than they are to the customer. Botanical names serve the customer mainly as a protection that he is getting the correct plant for his location and will understand a light green, shiny leaf plant that grows 3'-4' high, but *Prunus laurocerasus* 'Zabeliana' might 'turn them off'. However, the nurseryman might guess a dozen different shrubs from the above description without mentioning *Prunus laurocerasus* 'Zabeliana'. Therefore, proper naming is vital for customer protection, legal requirements and nurserymen's communication.

Nursery salespeople need to practice constantly regarding the customer's interest in the plant so that flower color, shade, fragrance, or other benefits that the customer wants from the plant take precedence in the discussion over plant nomenclature. For most customers, the salesperson should use the common name the customer is comfortable or familiar with noting only any differences in local usage. At best, only use the botanical name as a reference point, never merely to show off knowledge the customer does not have or want.

To the novice, the number of names to learn seems overwhelming. It is not necessary or possible to know them all. One should memorize the principal plants that are used in the Pacific Northwest, and know how to look up plants in reference books for more information. The botanical name is the key to locate all the information that is written about a particular plant. Knowing botanical names will help set you apart as a professional horticulturist.

Many common names and botanical names are the same. As an aid in learning, it is wise to recognize botanical names derived from countries of origin, names of plant explorers and English words taken from the Latin. Camellia japonica should tell everyone the plant is from Japan. Words like chinensis, formosanum, carolinianum, washingtonia and mexicana are Latinized geographical names. Douglasii, darwinii, menziesii and nuttallii are taken from explorers. Equally easy to recognize are Latin descriptive names as gigantea, pygmaea, nana, rubra, nigra and hosts of others.

Botanical names can be extremely helpful to the nursery salesperson in telling him much about certain characteristics of the plants. For this reason, further study of the scientific or botanical names is recommended. The meanings of some of these Latin words that help describe a plant are:

affinis— related
alatus— winged
alba— white
albiflorus— white flowered
alpestris— nearly alpine
alpinus— alpine
alternifolia— alternate-leaved
altissima— tallest
amabilis— lovely
angulatus— angular, angled
angustifolius— narrow-leaved
apiculata— short pointed tip
aquifolium— holly leaved
arborea— treelike, woody
arenarius— of sand or sandy places
argentea— silvery
attenuata— slenderly tapering
aureus— golden
australis— southern
baccatus— berried
barbatus— barbed, bearded
bipinnata— twice pinnate (leaflets on each side of a common petiole, like a feather)
brevicaulis— short stemmed
brevifolius— short leaved
buxifolius— box leaved
campestris— of the fields or plains
canadensis— from Canada
candidus— pure white, shining
coccineus— scarlet
communis— common, general
concolor— of uniform color
confertus— crowded; pressed together
cordate— heart shaped
crassifolius— thick leaved
crenata— toothed, teeth rounded
crenulatus— finely scalloped
cuspidata— short, rigid point
cyaneus— blue
debilis— weak, frail
decorus— elegant, comely, becoming
decurrens— running down the stem
densiflorus— heavily flowered
denticulata— toothed slightly or minutely
dimorphous— occurring in two forms
dioecious— male and female flowers of separate plants
divergens— wide spreading
edulis— edible
elatus— tall
elegans— elegant, beautiful
elongatus— elongated, lengthened
falcatus— like a sickle
fastigiatus— branches errect and close together
floribunda— free flowering
floridus— flowering freely
fragilis— fragile, brittle
fruticosus— shrubby
glauca— with white or gray as on blue spruce
globosa— globe shaped
gracilis— graceful, slender
grandiflorus— large flowered
herbaceous— non-woody above ground stem
hirsuta— with coarse or stiff hairs
illicifolius— ilex-leaved, holly-leaved
inermis— unarmed, without thorns
japonica— of Japan
laciniatus— torn, fringed
lanceolate— shaped like a lance-head
lineatus— with lines or striped
littoralis— of the seashore
lucidus— bright, shining, clear
lusitanicus— of Portugal
lutescens— yellow
mas— male
marginatus— with a margin or striped
maximus— largest
macrophyllus— large leaved
microphylla— small leaved
mollis— soft, soft-hairy
monstrosus— monstrous, abnormal
mucronata— with small, abrupt tip
multicolor— many-colored
nana— dwarf
Niger, nigra— black
nivalis— snowy, white
obtusa— blunt
occidentalis— western, New World
odoratissimum— very fragrant
officinalis— medicinal
oxycanthus — sharp-spined
papyrifera— paper bearing
parviflorus— small-flowered
pendulus— pendulous, hanging
petiolaris— with a leafstalk
pisifera— pea-bearing
platucladus— broad-branched
plicata— planted, folded lengthwise
polyanthus— many-flowered
procerus— tall
procumbens— trailing, prostrate
prolifera— many-leaved
prostratus— lying flat
pubescens— short, soft hairs: downy
pumilis— dwarf
pungens— piercing; sharp-pointed, sharp tasting
purpurea— purple
pyramidalis— like a pyramid; inverted cone
quinquefolia— five leaves or leaflets
radiatus— rayed
radicans— rooting

recurvata— bent backward, reversely curved
repens, reptans— creeping
rex— king
rhytidophyllus — wrinkle-leaved
rigidus— stiff
rotundifolius— round-leaved
rugosa— wrinkled
saccharum— of sugar
saxatilis— found among rocks
scabrous— rough to the touch
sempervirens— evergreen
serrata— serrate, toothed
speciosus— showy, good-looking
squamatus— with scale-like leaves or bracts
stellata— starlike
stoloniferous— producing runners that root
stricta— upright, with few or no branches
suffruticosa— shrubby
sylvatica— forest-loving
ternatus— in threes (as clover leaflets)
tremuloides— quivering, trembling
triacanthos— three-spined
truncata— cut off squarely
umbraculifera— umbrella-bearing
undulata— waxy surface or margin
vegetus— vigorous
verrucosa— warty
verticillatus— whorled
viridis— green
viscosus— sticky
vulgaris— common
whorl— leaves, etc., in a circle around stem

List of Landscape Plants

The examination will have a section in which you will identify a selection of plants from this list. Your knowledge of these plants should also include ability to write a basic description such as growth habit, fruit or flower color and typical identification features. The following entries are listed alphabetically according to botanical name, within five growth habit categories. An asterisk (*) means that the plant is semi-deciduous at times.

Some botanical names have had to be corrected; the old names are in parentheses. Whenever species, varieties or cultivars are indicated after a genus, assume that you should learn the ones commonly used in your area as any of these may be on your examination.

Evergreen Trees

Abies amabilis
Silver Fir
Abies concolor
White Fir
Abies grandis
Grand Fir
Abies lasiocarpa
Alpine Fir
Abies procera
Noble Fir
Arbutus menziesii
Madrona
Calocedrus decurrens
Incense Cedar
Cedrus atlantica 'Glauca'
Blue Atlas Cedar
Cedrus deodara
Deodar Cedar
Magnolia grandiflora
Southern Magnolia
Picea pungens 'Glauca'
Colorado Blue Spruce
Pinus aristata
Bristlecone Pine
Pinus contorta
Shore Pine
Pinus nigra
Austrian Black Pine
Pinus sylvestris
Scotch Pine
Pinus thunbergii
Japanese Black Pine
Pseudotsuga menziesii
Douglas Fir
Sciadopitys verticillata
Umbrella Pine
Sequoia sempervirens
Coast Redwood
Sequoiadendron giganteum
Giant Sequoia
Thuja plicata
Western Red Cedar
Tsuga heterophylla
Western Hemlock
Tsuga mertensiana
Mountain Hemlock

Evergreen Shrubs

Abelia grandiflora
Glossy Abelia
Arbutus unedo
Strawberry Tree
Aucuba japonica
Aucuba, Japanese Aucuba
Berberis julianae
Wintergreen Barberry

Berberis verruculosa
Warty Barberry
Buxus sempervirens
English Boxwood
Calluna vulgaris
Scotch Heather
Camellia japonica
Common Camellia varieties
Camellia sasanqua
Sasanqua Camellia varieties
Chamaecyparis lawsoniana 'Allumii'
Allumi Cypress, Blue Lawson Cypress
Chamaecyparis lawsoniana 'Ellwoodii'
Ellwood Cypress
Chamaecyparis obtusa
Hinoki Cypress
Chamaecyparis pisifera 'Filifera'
Thread Cypress, Threadbranch Cypress
Choisya ternata
Mexican Orange
Cistus corbariensis
White Rockrose
Cortaderia selloana
Pampas Grass
Cytisus praecox
Moonlight Broom

Daphne odora
Winter Daphne
Erica carnea
Winter Health
Escallonia rubra
Escallonia
Fatsia japonica
Fatsia, Aralia
Gaultheria shallon
Salal
Ilex aquifolium
English Holly
Ilex cornuta 'Burfordii'
Burford Holly

Ilex crenata convexa
Convex-leaf Japanese Holly
Juniperus chinensis 'Pfitzeriana'
Pfitzer Juniper
Juniperus chinensis 'Kaizuka'
('Torulosa')
Hollywood Juniper
Juniperus scopulorum cultivars
Rocky Mountain Juniper varieties
Kalmia latifolia
Kalmia, Mountain Laurel
Leucothoe fontanesiana
Drooping Leucothoe (catesbaei)
Ligustrum japonicum
Waxleaf Privet, Japanese Privet
Mahonia aquifolium
Oregon Grape
Mahonia nervosa
Low Oregon Grape, Cascades Mahonia
Nandina domestica
Nandina, Heavenly Bamboo
Osmanthus delavayi
Delavay Osmanthus
Osmanthus heterophyllus
Hollyleaf Osmanthus
Pernettya mucronata
Chilean Pernettya
Photinia fraseri
Fraser Photinia
Phyllostachys aurea
Golden Bamboo
Picea abies 'Nidiformis'
Nest Spruce, Bird's Nest Spruce
Picea glauca albertiana 'Conica'
Dwarf Alberta Spruce
Pieris formosa forrestii
Chinese Pieris
Pieris japonica
Japanese Pieris
Pinus densiflora 'Umbraculifera'
Tanyosho Pine
Pinus mugo
Mugo Pine
Prunus laurocerasus
English Laurel
Prunus laurocerasus 'Otto Luykens'
Otto Luykens Laurel
**Pyracantha coccinea* 'Lalandei'
Lalandei Pyracantha, Lalandei Firethorn
Raphiolepis indica 'Rosea'
Rosea Raphiolepis, Pink India Hawthorn

Rhododendron species and cultivars
Evergreen Azaleas and Rhododendrons
Rosmarinus officinalis
Rosemary
Sarcococca ruscifolia
Fragrant Sarcococca
Skimmia japonica
Japanese Skimmia
Stranvaesia davidiana undulata
Low Stranvaesia
Taxus baccata 'Repandens'
Spreading English Yew
Taxus media 'Hicksii'
Hick's Yew
Thuja occidentalis 'Fastigiata'
Pyramidal arbor-vitae
Thujopsis dolobrata
Hiba False Arborvitae
Trachycarpus fortunei
Windmill Palm
Umbellularia californica
Oregon Myrtle, California Bay
Vaccinium ovatum
Evergreen Huckleberry, Box Blueberry
•*Viburnum burkwoodii*
Burkwood Viburnum
Viburnum davidii
Davidi Viburnum
Yucca filamentosa
Adam's Needle Yucca

Deciduous Trees

Acer circinatum
Vine Maple
Acer ginnala
Amur Maple
Acer macrophyllum
Bigleaf Maple
Acer negundo 'Variegatum'
Variegated Box Elder
Acer palmatum
Japanese Maple
Acer platanoides
Norway Maple
Acer rubrum
Red Maple
Acer saccharum
Sugar Maple
Aesculus hippocastanum
Common Horsechestnut
Betula papyrifera
Paper Birch
Betula pendula
European White Birch
Betula pendula 'Dalecarlica' ('Laciniata')
Cutleaf Weeping Birch
Carpinus betulus fastigiata
Narrow European Hornbeam
Catalpa speciosa
Western Catalpa
Cornus florida
Eastern Dogwood
Cornus mas
Cornelian Cherry
Cornus nuttallii
Pacific Dogwood
Crataegus lavallei
Carriere Hawthorn
Crataegus oxycantha 'Paul's Scarlet'
Paul's Scarlet Hawthorn
Elaeagnus angustifolia
Russian Olive
Fagus sylvatica 'Purpurea'
Purple Beech
Fraxinus ornus
Flowering Ash
Ginkgo biloba
Ginkgo, Maidenhair Tree
Gleditsia triacanthos 'Sunburst'
Sunburst Honey Locust
Laburnum waterii "Vossii'
Vossi Goldenchain Tree
Liquidambar styraciflua
American Sweetgum
Liriodendron tulipifera
Tulip Tree
Malus cultivars
Crabapple
Oxydendrum arboreum
Sourwood
Platanus acerifolia
London Plane Tree
Populus nigra 'Italica'
Lombardy Poplar
Populus tremuloides
Quaking Aspen
Prunus blireana
Blireana Flowering Plum
Prunus serrulata 'Shirotae'
Mt. Fuji Flowering Cherry

Prunus subhirtella 'Autumnalis'
Autumn Flowering Cherry
Pyrus calleryana 'Bradford'
Bradford Pear
Quercus coccinea
Scarlet Oak
Quercus garryana
Oregon White Oak
Quercus palustris
Pin Oak
Quercus rubra (borealis)
Northern Red Oak

Salix babylonica
Weeping Willow
Sorbus aucuparia
European Mt. Ash
Stewartia pseudo-camellia
Japanese Stewartia
Styrax japonica
Japanese Snowbell
Tilia cordata
Little-leaf Linden
Ulmus pumila
Siberian Elm

Deciduous Shrubs

Berberis thunbergii
Japanese Barberry
Chaenomeles speciosa
Flowering Quince
Cornus stolonifera
Red Osier Dogwood
Cotinus coggygria
Smoketree
Cotoneaster horizontalis
Rock Cotoneaster
Deutzia gracilis
Slender Deutzia
Elaeagnus umbellata
Autumn Elaeagnus
Enkianthus campanulatus
Enkianthus
Euonymus alatus
Winged Euonymus
Forsythia intermedia
Forsythia, Border Forsythia
Hamamelis mollis
Chinese Witchhazel
Hydrangea macrophylla
Garden Hydrangea, Bigleaf Hydrangea
Hydrangea quercifolia
Oakleaf Hydrangea
Kolkwitzia amabilis
Beauty Bush

Ligustrum vulgare
Common or English Privet
Magnolia soulangeana
Saucer Magnolia
Magnolia stellata
Star Magnolia
Philadelphus cultivars
Mock Orange cultivars
Potentilla fruticosa
Potentilla Cinquefoil
Rhododendron
Deciduous Azalea
Rhus typhina
Staghorn Sumac
Rosa
Rose
Spiraea cultivars
Spiraea cultivars
Symphoricarpos albus
Common Snowberry
Syringa vulgaris
Common Lilac
Viburnum plicatum (*tomentosum* 'Sterile')
Japanese Snowball
Wiegela var cultivars
Weigela varieties

Groundcovers and Vines

Ajuga reptans
Carpet Bugle
Ev. Groundcover
Arctostaphylos uva-ursi
Kinnickinnick
Ev. Groundcover
Ceanothus gloriosus
Point Reyes Ceanothus
Ev. Groundcover

Clematis species
Clematis
Dec. and Ev. Vine
Cotoneaster dammeri
Bearberry Cotoneaster
Ev. Groundcover
Euonymus fortunei 'Coloratus'
Purple-leaf Winter Creeper
Ev. Groundcover

Fatshedera lizei
Fatshedera
Ev. Vine, Groundcover

Festuca ovina 'Glauca'
Blue Fescue
Ev. Groundcover

Gaultheria procumbens
Wintergreen, Checkerberry
Ev. Groundcover

Genista lydia
Lydia Broom
Ev. Groundcover

Hedera helix
English Ivy
Ev. Groundcover, Vine

Hypericum calycinum
St. Johnswort, Aaron's Beard
Ev. Groundcover

Juniperus horizontalis 'Bar Harbor'
Bar Harbor Juniper
Ev. Groundcover

Juniperus sabina 'Tamariscifolia'
Tam Juniper
Ev. Groundcover

Lonicera japonica 'Halliana'
Hall's Honeysuckle
Ev. Vine

Pachysandra terminalis
Japanese Pachysandra, spurge
Ev. Groundcover

Parthenocissus tricuspidata
Boston Ivy
Dec. Vine

Polystichum munitum
Western Sword Fern
Ev. Groundcover

Sarcococca humilis
Small or Low Sarcococca
Ev. Groundcover

Sagina subulata
Iris Moss
Ev. Groundcover

Sedum
Stonecrop
Ev. Groundcover

Sempervivum tectorum
Hen and Chicks
Ev. Groundcover

Thymus serpyllum
Mother-of-thyme
Ev. Groundcover

Vaccinium vitis-idaea
Lingonberry
Ev. Groundcover

Vinca minor
Vinca, Common periwinkle
Ev. Groundcover

Wisteria floribunda
Japanese Wisteria
Dec. Vine

Houseplants

Adiantum sp.
Maidenhair Fern

Aglaonema modestum
Chinese Evergreen

Anthurium
Tail Flower

Aphelandra squarrosa
Zebra Plant

Araucaria heterophylla
Norfolk Island Pine

Asparagus densiflorus 'Sprengeri'
Asparagus Fern

Azalea
Azalea

Begonia semperflorens
Fibrous Rooted Begonia

Brassaia actinophylla
Schefflera or Queensland Umbrella Tree

Caladium hortulanum
Fancy-leafed Caladium

Calceolaria sp.
Calceolaria species

Chamaedorea elegans
Dwarf Palm, Neanthe Bella Palm

Chlorophytum comosum
Spider Plant

Chrysanthemum morifolium
Chrysanthemum

Cissus rhombifolia
Grape ivy

Coleus blumei
Coleus

Crassula argentea
Jade

Cyclamen sp.
Cyclamen species

Cyperus alternifolius
Umbrella Plant

Dieffenbachia picta
Dumb-cane

Dizygotheca elegantissima
Thread-leaf False Aralia

Dracaena deremensis
Common dracaena

Euphorbia pulcherrima
Poinsettia

Ficus benjamina
Weeping Fig

Ficus elastica
Rubber Plant

Ficus lyrata
Fiddleleaf Fig

Fuchsia sp.
Fuchsia species

Gynura sarmentosa
Velvetplant

Hedera helix
English Ivy

Impatiens sp.
Balsam, Touch-me-not, Busy Lizzie

Iresine herbstii
Bloodleaf

Kalanchoe blossfeldiana
Kalanchoe

Maranta leuconeura kerchoviana
Arrowroot

Monstera deliciosa
Split-leaf Philodendron

Nephrolepis exalta 'Bostoniense'
Boston Fern

Pelargonium sp.
Geranium species

Peperomia sp.
Peperomia species

Philodendron cordatum
Trailing Philodendron

Popypodium sp.
Polypody Ferns

Pilea cadierei
Aluminum Plant

Rhaphidophora aurea
Ivy-arum

Saintpaulia ionantha
African Violet

Sansevieria trifasciata laurentii
Snake Plant, Bow String Hemp

Saxifraga sarmentosa
Strawberry Geranium

Sinningia speciosa
Gloxinia

Tradescantia fluminesis
Wandering Jew

Zygocactus truncata
Christmas Cactus

Summary

In order to separate and identify the many hundreds of different plants available in the Pacific Northwest, it is necessary that they have names that are easily recognized. Throughout history, plants have been given "common names" generally based on some characteristic such as the aroma of the flower, shape of the leaf, etc.

Unfortunately, a certain amount of duplication has resulted from this method of naming. To avoid this confusion, all plants have been assigned botanical or scientific names made up of the genus and species, plus cultivar where necessary.

Knowledge of these scientific names is essential in the nursery industry for communication within the industry.

The nursery salesperson should be familiar with these scientific names, yet generally be prepared to use common names only with his customers.

In many cases, the scientific name describes some definite characteristic of the plant such as flower color, growth characteristics or point of origin.

We don't have pictures of all of the plants on the list and some plants are pictured that aren't on the list, but the illustrations are good and helpful for your identification.

Supplementary Reading

Brooklyn Botanic Garden Handbooks, 1000 Washington Avenue; Brooklyn, N.Y. 11225.

Hilliers' Manual of Trees and Shrubs, American Edition, A. S. Barnes and Co., Inc., Cranbury, New Jersey 08512.

Manual of Cultivated Plants, revised edition: L. H. Bailey: Macmillan Publishing Co., Inc., New York.

New Pronouncing Dictionary of Plant Names, Florists Publishing Co., 310 South Michigan Street: Chicago, Ill 60604.

Trees and Shrubs for Pacific Northwest Garden, Grant and Grant, Pacific Books; Palo Alto, California.

Trees of North America, Brockman, Golden Press; New York.

Sunset Western Garden Book, Lane Publishing Co.; Menlo Park, California.

University of Washington Arboretum Bulletin, Arboretum Foundation, University of Washington Arboretum; Seattle, Washington 98195.

Wayside Gardens Catalog, $2.00, Mentor, Ohio 44060.

Landscape Design

Plant Science --- Local Adaption

Introduction:

This is one of six Plant Science Local Adaption Units. Select the unit which fits the local community needs best. The six units include:

1. Berry Production
2. Grass Seed Production
3. Nursery Production
4. Landscape Design
5. Christmas Tree Production
6. Range

Objectives:

Upon completion of this unit, the student will be able to:

1. Complete a site analysis.
2. Use landscape symbols.
3. Use landscape principles in designing a landscape of their own.
4. Design and layout a landscape plan.
    a. Landscape a public area.
    b. Landscape a private area.
    c. Landscape a service area.
5. Select plants appropriate to the landscape design developed.

References:

1. This unit was taken from "Landscape Design" - student materials available from the Agriculture Education Department, University of Arizona, Tuscon, Arizona 95721.

2. Another option for text materials is "Landscaping: Principles and Practice" 1978, Delmar.

3. Certified Nurseryman's Manual

   Oregon Assoc. of Nurseryman
   0224 S.W. Hamilton
   Portland, Oregon 97201

   Use this manual for plant identification list for Oregon (See Appendix A this unit).

Instructor Activities:

1. Duplicate or secure copies of this material for teaching.
2. Use field trips to show students good and bad landscapes.
3. Develop a slide set to illustrate principles and show students good and bad designs.

Student Activities:

1. Participate in discussions and field trips, do readings.
2. Develop a landscape plan for their own home.

TABLE OF CONTENTS

Page

- Foreword 1
- References 1
- Table of Contents 3
- INTRODUCTION 5
- SITE ANALYSIS 7
  - Natural Assets and Limitations 8
    - Soil 8
    - Climate 8
    - House Orientation 9
    - Topography 9
    - Existing Vegetation 9
    - Utilities 9
    - Legal Aspects 9
  - Time and Needs of Owner 11
- LANDSCAPE DRAWING TECHNIQUE 15
  - Drawing Equipment 16
  - Types of Landscape Views 17
  - Landscape Drawing Symbols 17
  - Principles of Landscape Design 19
    - Balance 19
    - Simplicity 20
    - Scale or Proportion 21
    - Contrast 21
    - Harmony 23
    - Repetition 23
    - Variety 23
    - Sequence 23
    - Color 25
    - Texture 25
    - Mass 26
  - Design Planning and Layout 27
    - Preliminary Sketching 27
    - Design Planning 28
- LANDSCAPING THE PUBLIC AREA 29
  - Walks and Driveways 30
  - Focal Point 31
  - Landscape Composition 32
    - Background 33
    - Enframement 33
    - Well-placed Accents 34
    - Attractive Foreground 34

Page

LANDSCAPING THE PRIVATE AREA. 38
  Requirements for Outdoor Living 39
    Privacy 39
    Livable Touch 39
    Year Round Interest 40
    Climate Control 40
    Design. 40
  Planning Considerations 40
    Landscape Patterns. 40
    Patios. 41
    Screening 41
    Neighbor's Views. 41
    Planting Beds 41
    Lawns 41

LANDSCAPING THE SERVICE AREA. 42

SELECTING PLANT MATERIAL. 43
  Classes of Landscape Plants 43
    Foundation Plants 43
    Framing Plants. 43
    Groundcovers. 44
    Screen and Border Plants. 44
    Beds of Color 44
    Accent Plants 47
  Habit of Growth 47
  Mature Height and Shape 49
  Plant Hardiness 50
  Maintenance Requirements. 50
  Other Considerations. 50

LANDSCAPE DESIGN

INTRODUCTION

Landscape design is the art of arranging and "fitting together" land, plants and building for human use and enjoyment. At the same time, it promotes the protection of the environment. It is a "conscious rearrangement of land for use and pleasure."

The purpose of landscape design is to create a plan which, when carried out, will result in the most attractive setting, using the most of the site's natural advantages. A site is landscaped to increase its usefulness, beauty, and economic value.

Proper landscaping should have utility as well as beauty. Walks, drives, patios, and parking areas are necessary in order to carry on the daily routine of a family. Walks and drives should be constructed to provide ready access to the house, garage, and terrace. Also, walks and drives should be appropriate size for comfortable use. They should be durable, non-slippery, and as attractive as possible. Their placement should allow for the attractive positioning of plant materials. Likewise, parking areas should be located and shaped so they are useful and blend attractively into the landscape. They should be aesthetically pleasing.

Another purpose of a landscape is to provide an attractive environment for the owner, the neighbors, and passing traffic. A street with well-landscaped houses makes a good impression and its beauty reflects the owner's pride in the appearance of his home grounds. An attractively-landscaped house is aesthetically pleasing. People see and appreciate the beauty that can be added with plant and structural materials and take pride in their landscaped property. If a neighbor's property is well-landscaped, the homeowner can enjoy the view rather than having to screen out unattractive off-site features.

Public opinions of an area largely depend upon it's landscaping. Neighborhoods with attractively landscaped properties usually have a reputation of being a good section in which to live. Neglected landscapes create a "negative" impression of the neighborhood.

Good landscaping improves the value of the property. The house will be more appealing to a prospective buyer because of the usefulness and attractiveness of the landscape features. A buyer also realizes the value of an established landscape rather than having to bear the expense and effort involved in establishing landscape materials around a new house. An attractive landscape in a good section of the city is often the final selling point needed to complete the sale of the home.

An established landscape can be enjoyed immediately. If a new landscape must be established, there could be a delay of several years before this enjoyment could be realized. In dollars and cents, an established, well-designed landscape adds approximately ten percent to the value of the property. The value increases each year as the plant materials, especially trees, grow toward maturity. Landscaping will continue to become more important as more people become aware of how well-landscaped homes, commercial establishments, and public areas contribute to their convenience, comfort, and feeling of well-being.

Until the middle of the nineteenth century, landscape design and home beautification were a part of the life of only the few wealthy people. When the industrial revolution began to provide the working class with more and more free time, they began to utilize their spare time in hobbies and other activities which provided pleasure. Many of these people directed their energies toward beautification of their lawns and home gardens.

It was soon evident that not only the outdoor and creative interests of people were satisfied by designing and working with landscaping, but this activity increased the value of their property. This new thrust of energy eventually led to the development of landscape design businesses and other landscape enterprises. People began to realize the planning of towns, cities, suburban developments, even a whole region, was essential to the improvement of the relationship of human beings to their outdoor physical environment. In home landscaping, the landscape architect today sees the house and garden as a single unit of liveable space. In the past, the house and lot were often thought of as entirely distinct areas.

Today, landscape design is a field which involves many people; including amateurs, commercial landscape designers, and landscape architects who prepare landscape plans. The landscape architect must have an academic background in art, engineering and horticulture; thus enabling them to hold the title and license of a landscape architect. Becoming involved in many facets of landscape design, the landscape architect:

1. Plots grades, drainage, watering systems, and walks and drives.
2. Designs garden structures such as outdoor rooms, shelters, plant houses, pools, walls, and gates.
3. Plans plant materials for municipal buildings, parks, etc.
4. Organizes outdoor space to fit the needs of clients.
5. Designs community development plans.

It is essential that a plan be prepared before attempting the landscape development. But, before actually attempting to prepare plans for a property, a careful survey of the area and its surroundings should be made.

SITE ANALYSIS

Whether selecting a vacant lot for a new home, or developing a plan for a home already built, several factors need to be considered. It is best to put as much distance as possible between a new home and airports, industry, or factories. Property values should be checked to make sure they have been increasing over the past few years. If the values have remained stable, or have fallen, try to find out the reason. If the reason for falling values is the neighborhood, look elsewhere before buying.

When choosing a neighborhood for a family residence, the following should be considered:

1. Location of churches, schools, parks, shopping centers, and stores.
2. Income levels of people in area.
3. Civic pride exhibited by area owners.
4. Personal interests, i.e., size of the lot, work area, greenhouses, etc.
5. Property and zoning regulations.

Zoning is an attempt by governmental agencies to plan for controlled use of land. This is done by restricting the use of the land within the community for specific purposes. Different zones are established for single dwelling units, multiple dwelling units, businesses, industry, etc. based upon the community's needs.

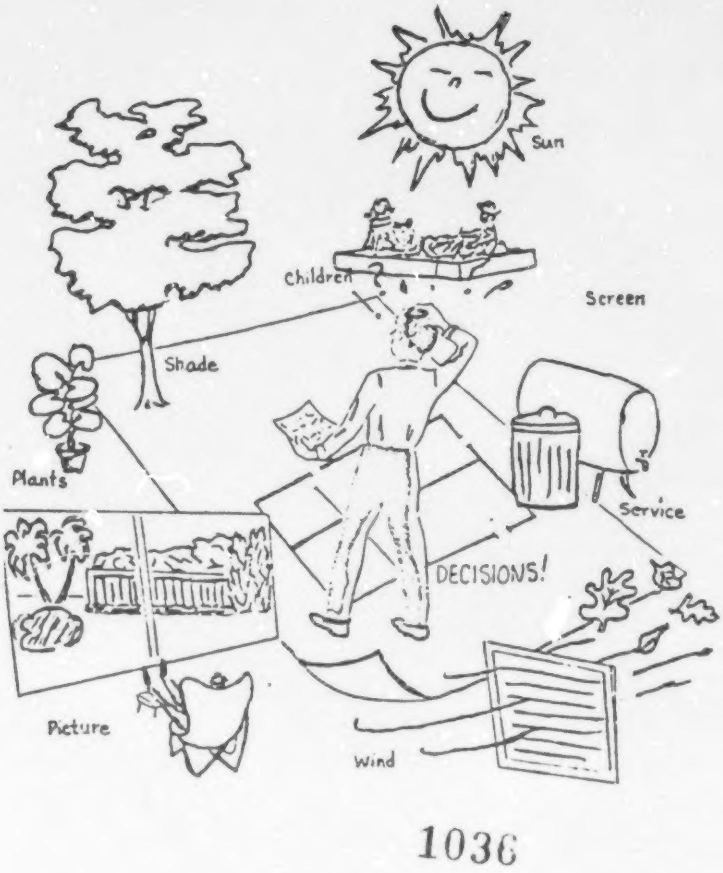
Carefully-made plans should be available before starting the landscape development of any home grounds. Plans for small properties are more detailed as these properties are generally more intensively used. For new properties, planning for the use of the grounds should be made before the house is built. The plan should include the selection or design of a house plan appropriate for the specific area concerned. This procedure will help assure that the finished development is attractive, as well as efficient for outside activities. The latter is important. The use of yard areas for various recreational activities has increased greatly in recent years.

Natural Assets and Limitations

When planning the landscape for a particular site, the first step is to analyze the natural assets and limitations. All factors known about the physical aspects of the property are listed. This list includes all elements of the environment such as: soils, climate, the orientation of the house on the land, the topography, existing trees and shrubs, utilities, and legal aspects (restrictions).

Soil: The soil type, depth, fertility, structure and drainage qualities of the site need to be recorded. Each type of soil has a different influence on the development of the site. Contact local soil conservation districts for recommendations.

Climate: The general climate and microclimates will influence plant material selections. Information concerning the amount of sun, wind, and shade is recorded for each area of the site. Also, the hardiness zone, winter temperature range, prevailing wind, and average summer rainfall should be noted. This information is available from local weather bureaus.



House orientation: The orientation of the house on the land determines its exposure to prevailing winds and the sun. Other structures such as out-buildings, walls, drives, walks, patios, and fences should be noted.

Topography: The topography, including slope and rock outcroppings, should be noted. Slope will help to determine drainage patterns and some rock outcroppings can be blended into the landscape. Also, the location of springs, brooks, marshy terrain, ponds, and bodies of water should be recorded.

Existing vegetation: Existing trees and shrubs must be included in the site evaluation to help determine their use in the landscape. Also, the size and condition of grass and bare soil areas should be indicated.

Utilities: Underground and overhead utilities must be noted to enable the designer to avoid planting trees where their branches or roots will interfere with water, gas, sewer, or electric lines.

Legal aspects: Legal aspects such as boundary lines, right-of-way, and setbacks must be recorded. Notes regarding deed restrictions, easements, and building and zoning regulations must be made. Certain city ordinances will not permit an obstruction of a view across a corner.

The following "Site Analysis Check-Off List" can be utilized to help determine whether the previously mentioned elements of the environment are assets or liabilities to the landscape site:

SITE ANALYSIS CHECK-OFF LIST

Location ______________________ Lot No. ___ Date ______________
Client Name ____________________ Telephone No. ______________

On Site Factors

Lot: Dimensions - length ________ width ________ plotted ____
Rights-of-way ______________________ plotted ____
Easements ________ kind ______________ plotted ____
Legal restrictions - setback ____________ plotted ____
lot lines ____________ plotted ____
corner obstruction ___ plotted ____
fence, setback ________ height ______
length ______ type _____
outbuilding __________
trees not permitted ______________

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Sidewalk: Installed__________location plotted____
Not installed__________future location plotted____
done by owner________city________
Never to be installed________contours plotted____
Drainage - adequate__________inadequate________
install tile lines______________________plotted____
Soil type - clay______loam____sand____muck____
Soil sample taken_____
Soil test results - pH____N___P____Ca____other____
Rock outcropping______________________plotted____

Water: Spring__brook___pond__marsh___other___plotted____

Existing Vegetation: Trees____species____height____width____plotted____
____ ____ ____ ____
____ ____ ____ ____
____ ____ ____ ____

Shrubs____species____height____width____plotted____
____ ____ ____ ____
____ ____ ____ ____
____ ____ ____ ____

Turf areas______________________plotted____
satisfactory________renovate________replace____
Bare soil______________________plotted____

Structures: House______length______width______plotted____
Front faces north_____east_____south_____west______
other________
Style____________________color (s)________
Material - brick____frame_____stone_____other______
Outer buildings - length______width_____plotted____
Materials______________________plotted____
Driveway______width______length______material____
plotted____
Walks________width______length______material____
plotted____
Terraces______width______length______material____
plotted____

Climate: Hardiness zone_____on plan_________prevailing wind
direction________on plan_________
Orientation - north indicated on plan____________
shade areas plotted____
sunlight control area plotted____
wind control area plotted____
snowdrift control area plotted____

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Utilities:

Overhead poles plotted __________ wires plotted ____
Underground water line __________ plotted ____
water valve __________ plotted ____
electric lines __________ plotted ____
electric meter __________ plotted ____
drainage lines __________ plotted ____
septic tank ______ drainage field ______ plotted ____
dry wells __________ plotted ____
gas line __________ plotted ____
gas valve __________ plotted ____
gas meter __________ plotted ____

Off Site Factors:

Favorable views -

Kind	height	width	season	plotted

Unfavorable views -

Kind	height	width	season	plotted

Pedestrian Traffic: Control needed _____ not needed _____ pattern plotted _____

Noise: Control needed __________ area plotted ____

Dust: Control needed __________ area plotted ____

Bright Lights: Car _____ parking _____ neighbor _____ other ______ area plotted ____

Time and Needs of Owner

Before developing the plan, consider the quantity of time the owner has to give to the maintenance of the grounds. Does he enjoy yardwork? Is there time for the essential chores? Or is capable help available? To serve any of its intended purposes, a garden will need some care. Certain yards demand more care and time than others. Often, careful initial planning reduces the amount of required attention.

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Does the owner have plenty of patience? Trees and shrubs take time to grow. This is a factor to consider during the planning stage. Quick-growing trees might serve the specific purpose or site, but such trees are short-lived and may have to be replaced early. Although not necessarily bad, it should be taken into account in the planning stage. Plants for replacement must be ready when fast growing plants are to be removed.

Although trees and some shrubs are slow-growing, they mature eventually. Some trees achieve a good deal of height in a few years. This must be recognized as they may outgrow the house, and even the lot. Often a mistake is made by forgetting that trees and shrubs grow two ways, sideways as well as up -- before too long a "jungle" develops in the yard. Today, personal preferences are easily satisfied with the wide range of available plant materials. Increased hardiness in many old favorites, extending their growing range, and the continued development of new hybrids with special qualities of desirability have made this possible.

The specific needs of the owner must be considered in arranging for public, private, and service areas. These needs will include the driveway and approach to the house; play areas for children; a pleasing place to relax, and vegetable and cutflower gardens. The service area where garden tools might be stored, garbage held for pick-up, trash burned, and laundry hung out to dry must be planned. With a landscaping plan, these areas can be separated by shrubs; thus, the "eyesores" are screened from public and the owner's view.

If the plan is started from "scratch", it is possible to plan the home and grounds as a single, interrelated unit. This is the ideal situation which will provide an overall interrelationship between ground and architecture, gaining complete harmony between the two.

Landscaping costs vary from site to site, primarily because of the complexity of the design, plant materials selected, and labor costs. Complete landscaping may cost from 10 to 20 percent of the value of the house and lot. These estimates include the cost of the design and their establishment. Landscaping cost must be considered primarily for the value it adds to the livability of the site. However, there have been cases where landscaping has added as much as 13 percent to the sale value of a home.

The following, "Analysis of Family Needs Check List," will aid in determining owner requirements of the home and landscape:

ANALYSIS OF FAMILY NEEDS CHECK LIST

Location ____________________ Lot No.___ Date ____________

Client Name ____________________ Telephone No. ____________

Number of Children - Pre-school _____ Elementary _____ High School _____

Activities **Needs**

Entertaining: Paved area - capacity (people) __________ size _______
color ____________ material __________ plotted _____
Shade - canopy ________ trellis __________
umbrella __________ tree ____________ plotted _____
Seating - benches ____________ capacity __________
no. ____________ style ____ plotted _____
chairs _____ no. _______ style ____ plotted _____
chairs - folding __________ no. ________
style ____ __________ storage ________
tables _____ no. _______ style ____ plotted _____

table - dining _________ capacity __________
style ____ plotted _____
Garden lighting ___ kind ___ style ___ no. ___ plotted _____
___ ___ ___ _____
___ ___ ___ _____

Cooking: Grill - permanent _____ size ____ style ____ plotted _____
portable _____ size ____ style ____ storage
plotted _____
Table - work ____ dimensions ____ style ____ plotted _____
Storage for cooking ________ dimensions ____ plotted _____
Electrical outlets ________ no. __________ plotted _____

Games: Croquet _____ dimensions ___30' x 60'___ plotted _____
Bowling on the green __________ dimensions __________
___10' x 50' or 20' x 100'___ plotted _____
Badminton ____ dimensions ___24' x 54'___ plotted _____
Volleyball ___ dimensions ___40' x 70'___ plotted _____
Basketball hoop ____ dimensions ___40' x 40'___ plotted _____
Tetherball ___ dimensions ___20' dia. cir.___ plotted _____
Horseshoes ________ dimensions ___20' x 40'___ plotted _____
Archery _____ dimensions ___20' x 100' min.___ plotted _____
Putting green __ dimensions ___30' dia. cir.
min.___ plotted _____
Shuffleboard ___ dimensions ______________ plotted _____
Other _________ dimensions ______________ plotted _____
Game storage ___ length _____ width __________ height _____
plotted ____

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Playing: Sandbox_____dimensions__________plotted____

Swings_____dimensions__________plotted____

Slide_____dimensions__________plotted____

Playhouse_____dimensions__________plotted____

Monkeybars_____dimensions__________plotted____

Wading pool_____dimensions__________plotted____

Blackboard_____dimensions__________plotted____

Other (specify_____dimensions__________plotted____

Storage, wheel, toys, etc._____dimensions__________

plotted____

Swimming: Pool_____dimensions__________

shape_____material__________plotted____

Diving board_____dimensions__________plotted____

Paved area_____dimensions__________

material__________plotted____

Enclosure__________plotted____

Equipment storage__________plotted____

Gardening: Minimum maintenance__________

Automatic watering system__________plotted____

Flower beds_____annuals_____perennials_____

roses_____mixed__________plotted____

Planter boxes_____kind_____plotted____

Water garden_____water lilies_____fountain

plotted____

dimensions__________

Cutting garden_____dimensions__________plotted____

Vegetable garden_____dimensions__________plotted____

Herb garden_____dimensions__________plotted____

Dwarf fruit trees_____kind_____no.___plotted____

__________ ___ ____

__________ ___ ____

Bush fruits_____kind_____no.___plotted____

__________ ___

__________ ___ ____

Vine fruits_____kind_____no.___plotted____

Favorite plants_____kind_____

_____

_____

_____

Ornaments_____statuary_____other_____plotted____

Coldframes_____dimensions__________plotted____

Greenhouse_____dimensions__________plotted____

Compost bin_____dimensions__________plotted____

Garden storage: equipment - mower_____

sweeper_____fertilizer spreader_____

hose_____sprinkler_____

duster_____sprayer_____

other__________plotted____

tools - spade_____

rake_____hoe_____hand tools_____

other__________plotted____

supplies - fertilizer_____

pest control_____other__________plotted____

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Bird Watching: Bird feeder ________________ plotted ____
Bird bath ________________ plotted ____
Bird houses ________________ plotted ____
Bird attracting shrubs ____________ plotted ____

Pets: Doghouse ____ dimensions ____________
run dimensions ________________ plotted ____
Other ______ dimensions ____________
run dimensions ________________ plotted ____

Laundry: Lines - permanent ____ linear ft. ______ plotted ____
temporary ____ linear ft. ______ plotted ____

Storage: Trash ________ no. container ________ sq. ft.
required ________________ plotted ____
Trailers ____ dimensions required ______ plotted ____
Boat ______ dimensions required ______ plotted ____
Other - specify ________________ sq. ft.
required ________________ plotted ____

COST

Approximate landscaping allowance (based on about 10% of the market value of the house and land): $____________.

Cost limitation set by client: from $____________ to $________

Execution period:

Years Approximate cost per year
1____ ______
2____ ______ ______
3____ ______ ______ ______
4____ ______ ______ ______ ______

LANDSCAPE DRAWING TECHNIQUE

Individuals engaged in landscape design activities must be able to skillfully draw and use plans and prints in a wide variety of situations. To improve landscape areas, a basic knowledge of landscaping drawing is essential.

Since the size of the landscape area is larger than the drawing, landscape plans are drawn to scale. A scale of 1/8 or 1/4 inch per foot is most commonly used. The scale (1/8" or 1/4" = 1') is noted on the drawing. Thus, landscape drawings are "scaled" using a value which presents the necessary components with consistent detail and accuracy.

Scales for building blueprints are generally larger than those for landscape drawings. The symbols are also much different, since landscape blueprints show the location of fixed objects as well as plant material.

Drawing Equipment

Before attempting to draw a detailed plan of a landscape, one must select suitable equipment. These materials and instruments are usually available through most art supply stores, and can be purchased in a wide range of quality and price.

The basic drafting materials and equipment used for landscape drawing include the following:

1. Drawing table or board.
2. T-square or drafting machine.
3. Triangles (30°, 60°, and 45°).
4. French curves.
5. Compass.
6. Templates (landscape symbols).
7. Lettering guide.
8. Pencils and pencil sharpener.
9. Scales (architects and engineers).
10. Rulers.
11. Erasers and eraser shield.
12. Paper.
13. Drafting tape.

The two most important pieces of equipment are the scale and the pencil. All other pieces of equipment can be improvised if necessary.

The function of the T-square is to provide an aid for drawing lines when used in conjunction with the triangles; horizontal, vertical, and angular lines can be drawn accurately. For most commercial operations, drafting machines replace the T-square and triangles. Curved lines and borders are drawn with the aid of a French curve. Special templates feature landscape symbols while others are used to draw almost any type of geometric design or symbol. These templates aid the landscape architect in drawing landscape features to scale.

The scale is used to determine measurements, not to draw lines. The architect's scale breaks down the inch into halves, quarters, eights, sixteenths, thirty-seconds, and sixty-fourths; it is used to measure all construction in feet and inches. The engineer's scale breaks down the inch into tenths, twentieths, thirtieths, fortieths, fiftieths, and sixtieths; this scale is used when measuring land surveys and distances in feet and tenths of feet.

Commercial landscape architects use transparent paper so drawings can be blueprinted. If the drawings are for personal use, they may be placed on heavy paper or graph paper for ease in drawing to scale.

Types of Landscape Views

Landscape drawings take many forms, but the orthographic drawings are used most frequently. They are much easier and less expensive to make than perspective drawings. Perspective drawings show all items or details exactly as it would appear in a photograph. Orthographic drawings are drawn to scale, usually showing only the top view. However, side or end views can also be shown orthographically.

In landscape drawings, orthographic top views are called plans while the front and side views are called elevations. Structural drawings are detailed drawings of particular structures, such as patios, steps, or foundations, in which the scale used is larger than for the plan. These structural drawings are orthographically-drawn and are attached to the working drawings.

A working drawing is the completed drawing with all pertinent information attached, which the landscape contractor uses to landscape the area. It should include the plan, elevations where necessary, structural drawings, enlargement of different areas, and all dimensions. All systems, such as irrigation, drainage, or wiring, should have separate drawings attached.

Landscape Drawing Symbols

Landscape symbols show the location and size of trees, shrubs, hedges, buildings, and permanent structures. They are used on the landscape plan to show the location of the various elements in the landscape design. Some of the more common symbols used in landscape drawing are illustrated in Figure 1.

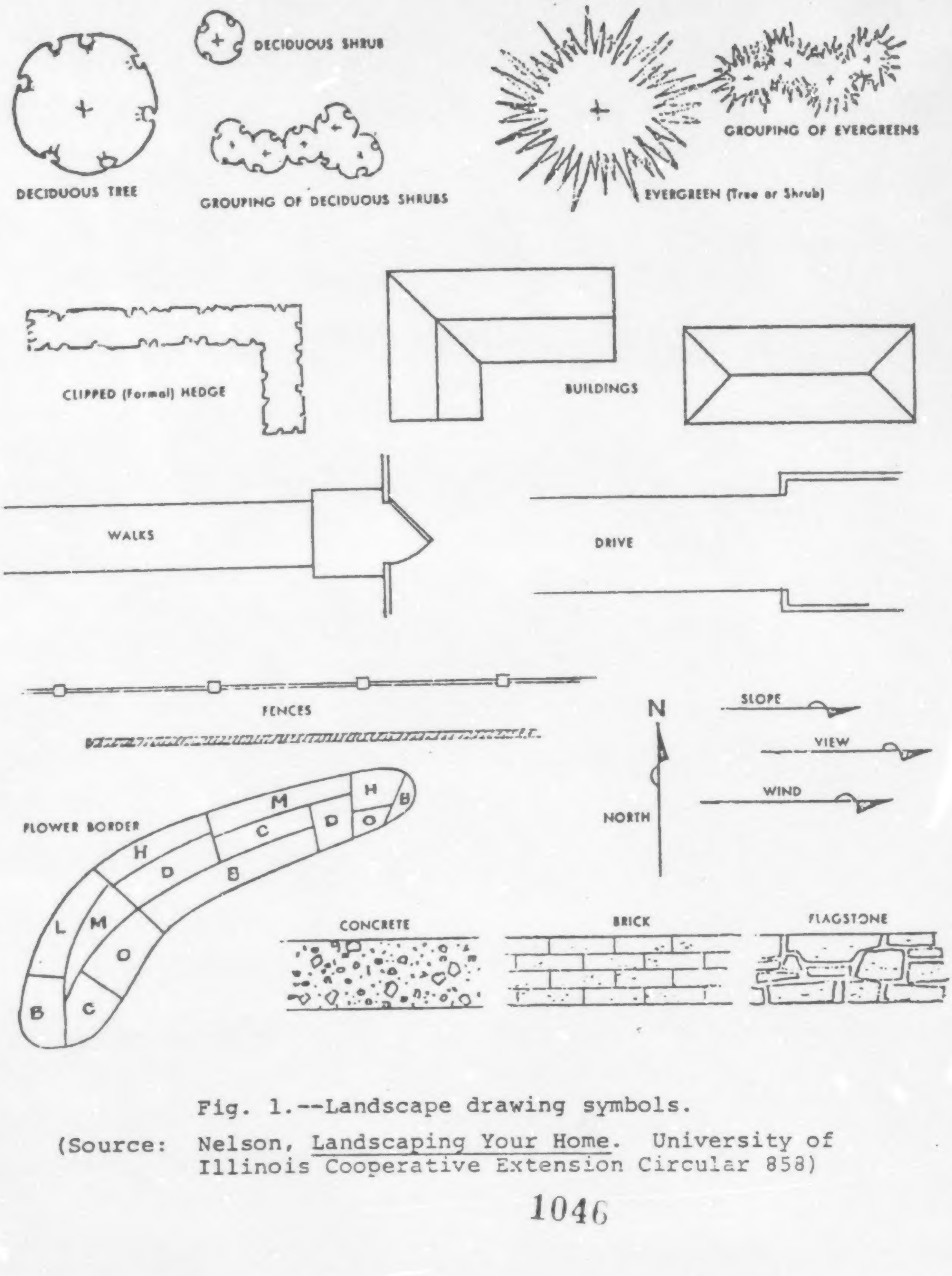

DECIDUOUS SHRUB
DECIDUOUS TREE
GROUPING OF DECIDUOUS SHRUBS
EVERGREEN (Tree or Shrub)
GROUPING OF EVERGREENS
CLIPPED (Formal) HEDGE
BUILDINGS
WALKS
DRIVE
FENCES
SLOPE
VIEW
WIND
N
NORTH
FLOWER BORDER
M
H
H
C
D
O
H
D
B
L
M
O
B
C
CONCRETE
BRICK
FLAGSTONE

Fig. 1.--Landscape drawing symbols.

(Source: Nelson, Landscaping Your Home. University of Illinois Cooperative Extension Circular 858)

Principles of Landscape Design

The principles of art applies to landscape design. The ultimate goal or purpose of all artistic effects is to achieve unity or a sense of completeness, plus harmony. In a design, there must be a primary focal point or center of interest around which the landscape plants, structures, and open spaces are grouped or balanced. The arrangement of these landscape elements blends together in a sequence leading to or away from the focal point. For example, the front door is the focal point of the front or public area of the home. Landscape elements are balanced around this point.

Balance: Mass, color, line or texture must be equalized on each side of a real or imaginary focal point to satisfy one's sense of balance. Balance can be achieved by either symmetrical or asymmetrical arrangement.

Symmetrical - Symmetrical balance is achieved when the plant arrangement on one side of the focal point is the exact duplicate of the other side. The basic design is rectangular. Formal gardens are a good example of this arrangement. Figure 2 illustrates symmetrical balance.

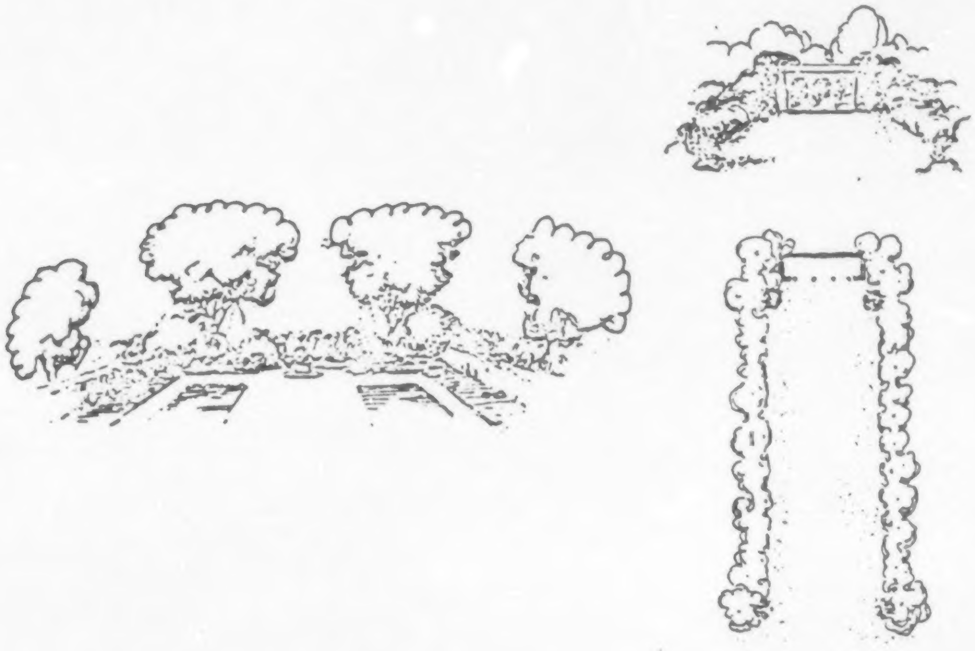


Fig. 2.--A formal vista showing symmetrical balance.

(Source: Bottomley, The Art of Home Landscape.
A. T. DeLaMare Co.)

Asymmetrical - Asymmetrical balance, an informal arrangement, is achieved through the use of contrast in shape and size. For example, a ground of small plants around a pool, or a group of plants used to "balance" a large open area of lawn. An informal design has more natural lines, and is not confined by rectangular forms or straight lines. Another example of asymmetrical balance includes a large tree within a group of shrubs. Figure 3 shows asymmetrical balance.

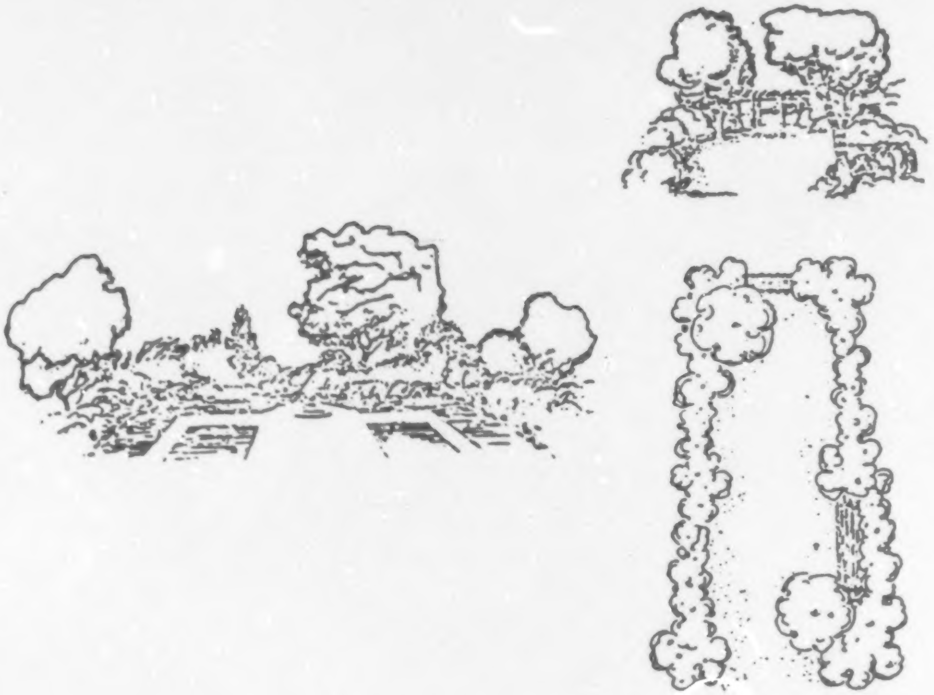


Fig. 3.--Asymmetrical balance and informal vista.
(Source: Bottomley)

Simplicity: Simplicity, shown in Figure 4, is achieved through a repetition of landscape materials. Repeat a few well-arranged forms, colors, or textures in various areas. If too many different kinds of plants are used in the design, simplicity is destroyed.

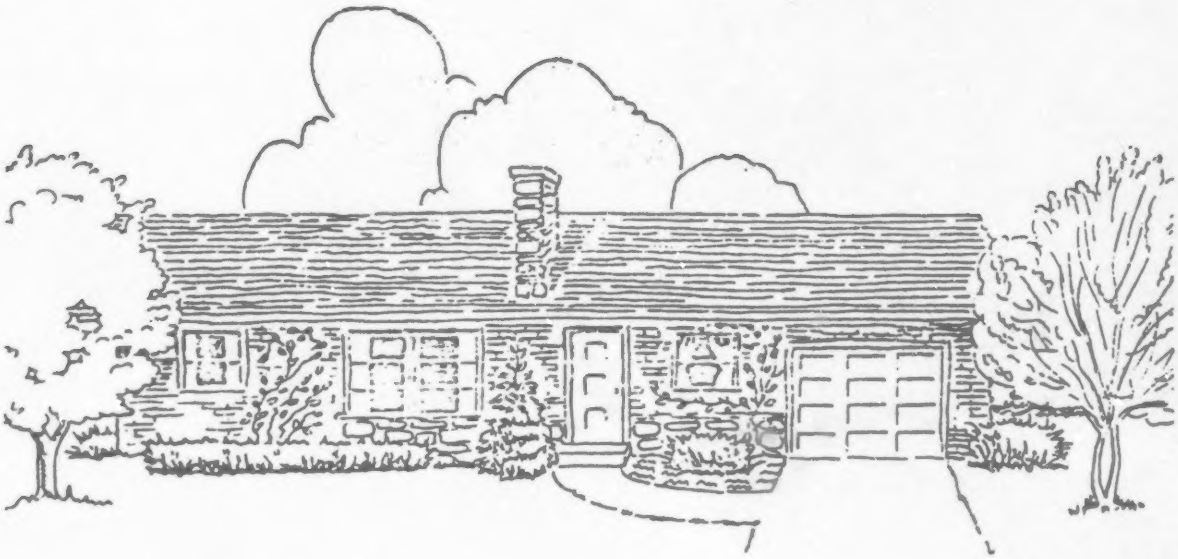


Fig. 4.--Principle of simplicity.

(Source: Kay, Landscaping Plans. D. Hill Nursery)

Scale or proportion: Scale means the size of units, such as open spaces, buildings, and plantings. Proportion is the pleasing relationship of one part of a design to another and each part's relationship of the whole. If the scale is kept consistent throughout, the design will have proportion. For example, if a lawn appears too long and narrow, it may have an unfavorable appearance by reminding someone of a bowling alley. A large shade tree needs a setting in scale with its size; otherwise, it will look crowded and uncomfortable. A low ranch style home will be in scale if a low-growing shade tree is used, while a tall, mature tree, as part of the setting, will achieve a sense of disproportion. A large house framed with small trees (Figure 5) appears even larger than it really is; whereas, a small house framed with large trees (Figure 6) appears smaller than it actually is.

Contrast: Contrast can be achieved by varying the size, texture, and color of plants (see Figure 7). A low plant near a tall one, or a broad leaf plant next to a narrow leaf plant, contrast one another. Contrast in plant colors is also used. A dark green evergreen offers a striking contrast against a white house.

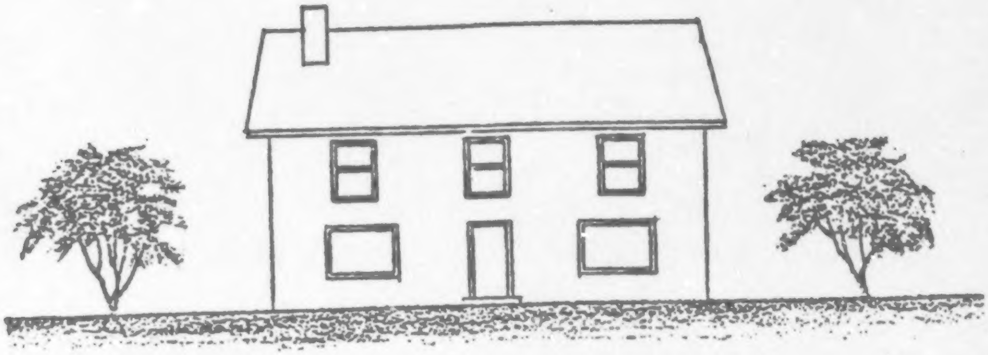


Fig. 5.--This house appears larger than it is because it is framed with small trees.

(Source: Nelson)

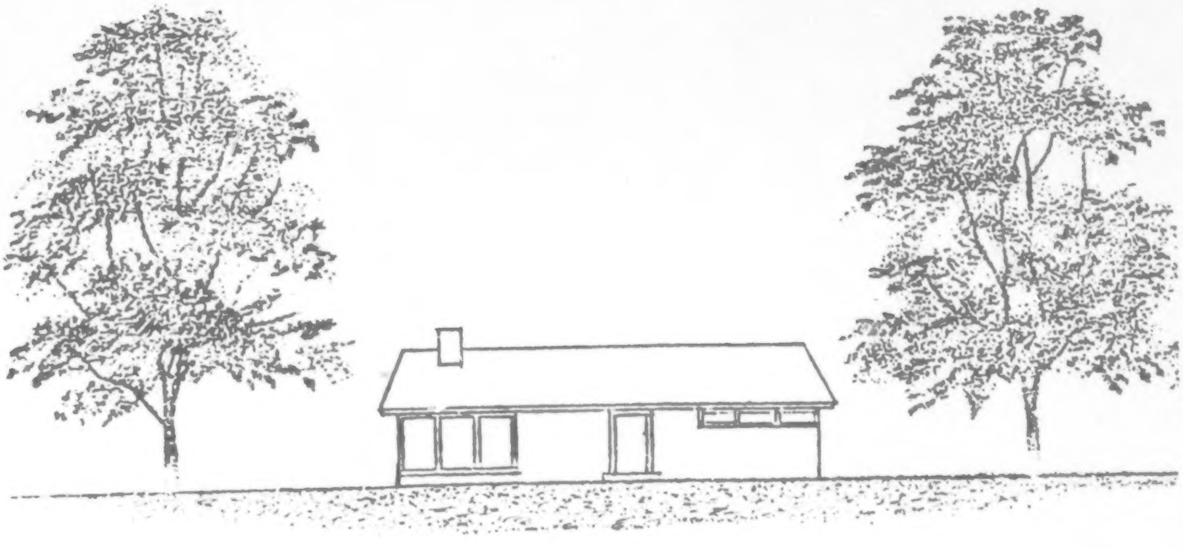


Fig. 6.-- A house looks smaller than it is by framing it with large trees.

(Source: Nelson)

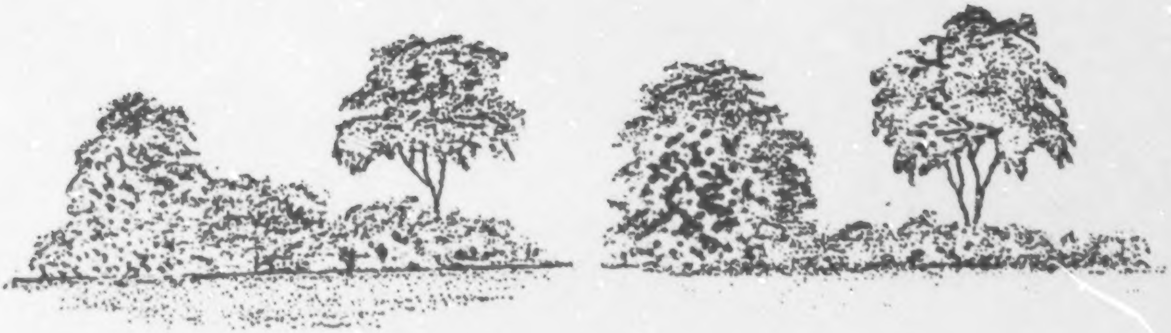


Fig. 7.--Principle of contrast.
(Source: Nelson)

Harmony: Harmony is achieved in a landscape when colors of various objects blend together rather than clash. This is especially true of exterior finishes, roof colors, and plant color combinations. Harmony may also be attained by grouping together three plants of one kind rather than placing a single plant.

Repetition: Repetition simply indicates the need for a reappearance of attractive materials in several locations in the landscape. Good repetition can be obtained by repeating the exterior finishes, roof colors, similar plants and other materials in several locations throughout the landscape. Figure 8 illustrates the use of repetition in a landscape.

Variety: In order to offset any monotonous effect of repetition, some variety in the choice of plants and other landscape materials must be used, as shown in Figure 9. Variety gives extra interest to outdoor areas around the home.

Sequence: An orderly, natural combination of landscape materials best describes the principle of sequence. Arranging of landscape materials in the proper sequence would be to place low objects in the foreground, intermediate objects in the far foreground and tall objects in the background (see Figure 10).

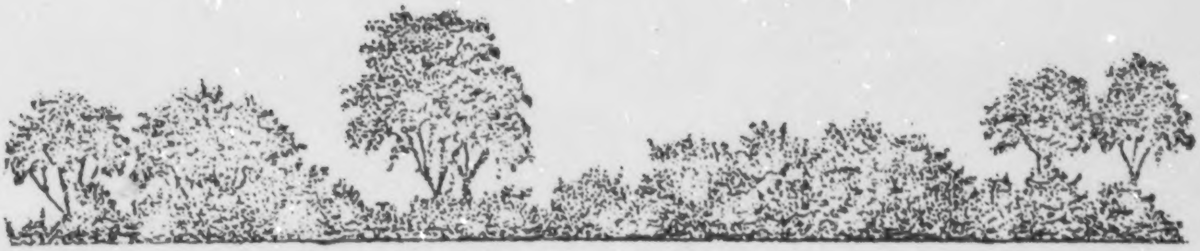


Fig. 8.--Repetition in a landscape. Other plant materials are used to help offset the monotonous effect of repetition.

(Source: Nelson)

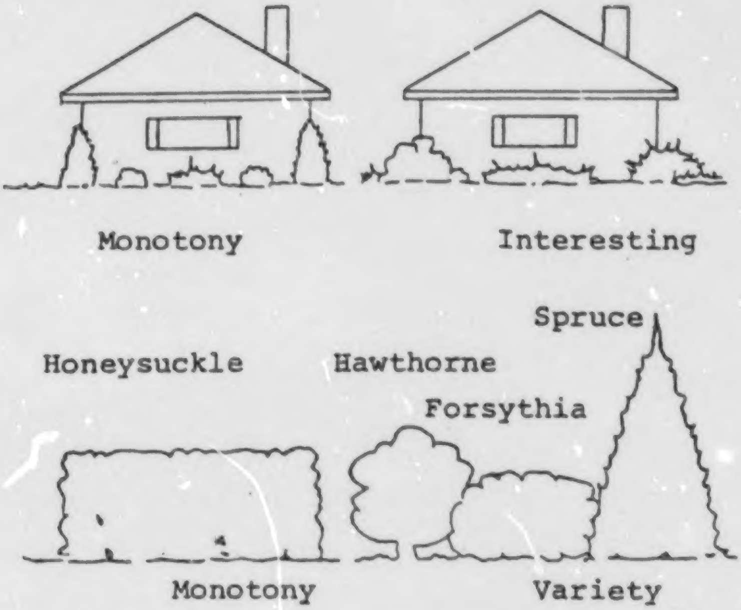
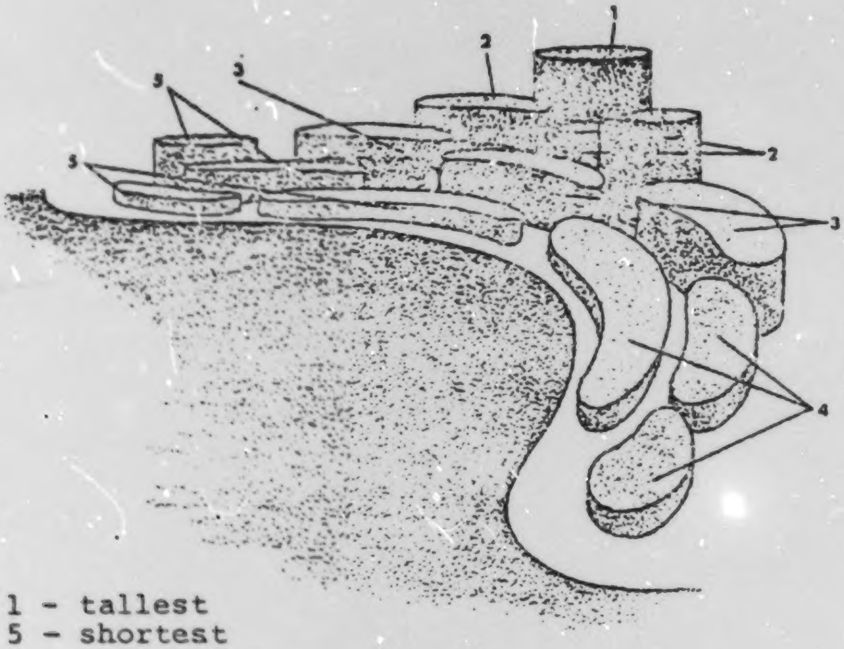

Monotony
Interesting
Spruce
Honeysuckle
Hawthorne
Forsythia
Monotony
Variety

Fig. 9.--Use of variety.

(Source: Kay)



1 - tallest
5 - shortest

Fig. 10.--Principle of sequence.
(Source: Nelson)

Color: Most plants used in landscaping are various shades of green; however, color can be added through the use of flowering or fruiting trees and shrubs. The flowering peach or plum, the crepe myrtle, and roses all produce an abundance of color with their flowers. The purple leaf plum provides color to the landscape through the color of its foliage and a pyracantha uses its berries to produce a vivid display of color.

In addition, annual and perennial flowers can be used as part of the landscape. They should be used with background structures such as a wall, fence, shrubs, or trees. Care should be taken not to concentrate on flowers that bloom early and are gone. Several different kinds of flowers that will bloom over a long period should be selected.

Texture: Landscape plants exhibit many forms of texture; namely, fine, medium, or coarse, with many gradation of each, as illustrated in Figure 11. Small close-spaced leaves, limber petioles, shiny surfaces, and dense, compact plants appear to be fine-textured, while on the other hand, large wide-spaced

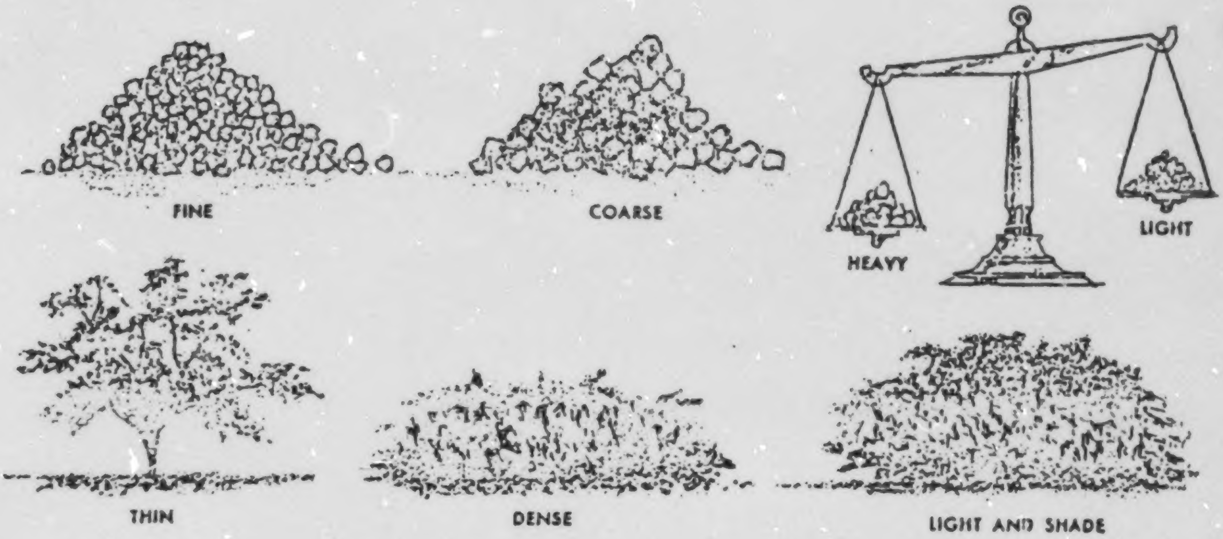


Fig. 11.--Texture.
(Source: Nelson)

leaves, stiff petioles, dull surfaces, and thin, rangy plants appear to be coarse-textured. Some plants can exhibit both a fine and a coarse texture depending on the time of year. Deciduous shrubs or trees may appear heavy and coarse in winter when branches and twigs are bare, but in summer, when covered with medium-sized leaves, they have a medium texture. In the spring with small blossoms these shrubs have a fine texture. Varying textures will avoid monotony and be pleasing to the eye. In Figure 12, pyramidal evergreen forms have been added to the predominant rounded forms. Variety may also be achieved by varying form and color while keeping texture constant; by varying color and texture while keeping form constant; or by varying texture while keeping both form and color constant.

Mass: Mass plays an important role in landscape design and is determined mainly by the density of form and structure of a plant. A plant which is considered to be light in mass exhibits a light color, thinness, and/or exposed irrigular structure; whereas, dense mass appears as a dark color, heaviness, and/or large structure.

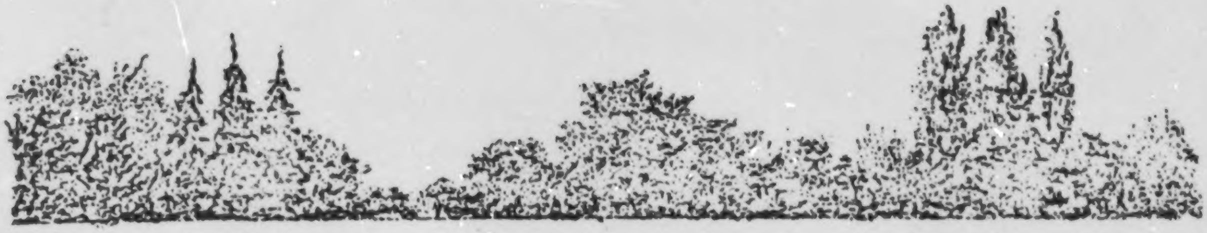


Fig. 12.—Texture with variety.
(Source: Nelson)

When working with plants in landscaping, the plant's attributes of color, texture, and mass should be varied only one at a time, keeping the other two constant. For example, if the plant material in use exhibits a coarse texture, light green color, and light mass, a change in the texture of subsequent plantings could be made while the light green color and light mass would remain the same.

Design Planning and Layout

Once the site analysis has been completed, all information should be plotted on a scale drawing. Then using the analysis of family needs, general planning ideas are plotted using a tracing paper overlay. In this manner, several overlay plans can be made without destroying the original scale drawing.

Preliminary sketching: The first sketch is made using the "goose-egg planning" technique. This is a process of roughly approximating the location of different areas of the landscape by drawing large "goose-egg" shapes to show these areas, as in Figure 13. It is used to help determine the space required for each area, the relationship of one area to another, and the changes needed in ground forms.

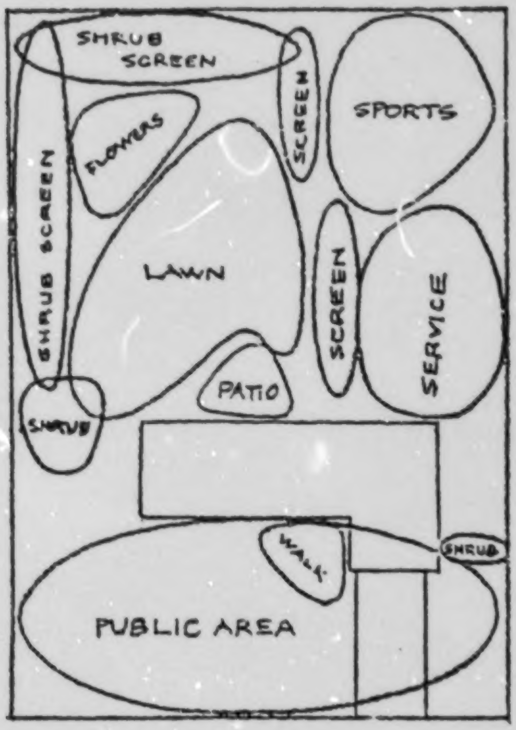

SHRUB SCREEN
SCREEN
SPORTS
FLOWERS
SHRUB SCREEN
LAWN
SCREEN
SERVICE
PATIO
SHRUB
WALK
SHRUB
PUBLIC AREA

Fig. 13.--Goose-egg planning.
(Source: Nelson)

If the lot is unusually shaped, such as pie-shaped, "goose-egg" sketching will determine the basic plan, since the boundary lines are the walls of the site. A long, narrow lot has the advantage of being partitioned into areas easily, but the transition between areas is difficult. The relationship between the primary living areas in the house and comparable areas outside must be evaluated. Any design must be considered from both within and outside of the house.

Design planning: Once the boundaries of the different areas to be landscaped have been decided, it is then possible to start the planting plan. However, since it is impossible to plan ahead for everything, it is perfectly acceptable to revise plans as the work progresses.

Some of the general rules of thumb to follow when designing a landscape are:

1. Symmetrical balance in a garden is rigid and formal. Subtle effects are achieved by asymmetrical balance.

2. A broad, simple curve is usually more desirable than a series of small curves.

3. Flower beds should be at least 2 feet to a maximum of 5 feet deep.

4. In general, everything in the landscape should be wider than it is tall.

5. In determining height, different objects should be of different height, while similar objects should be of similar height.

6. Straight lines should lead to something.

7. A raised edge provides interest in a flat yard.

The lot or site to be landscaped should be considered as a cube of space in which the ground is the floor, the property lines are the walls, and the ceiling is the canopy created by structures, tree plantings, or the sky. The basic design must reflect the natural surroundings of the area, yet, must also meet the needs of the family it is to serve.

The landscaped area is usually divided into three major sections: the public area, private area, and service area. Each area is landscaped for different purposes; however, all three must be designed to blend together. (Refer to Figure 14).

LANDSCAPING THE PUBLIC AREA

In home landscaping, public areas are seen by people as they pass by the house or approach it. Including land located between the house and the street, corner lots have larger public areas than others. The driveway, front walk and plantings, certain side plantings, and a lawn area make up the areas to be landscaped in the public area. In some situations, such as the narrow end of a pie-shaped lot, the public area may be very small. These public area components are designed to give the house an attractive setting on the lot.

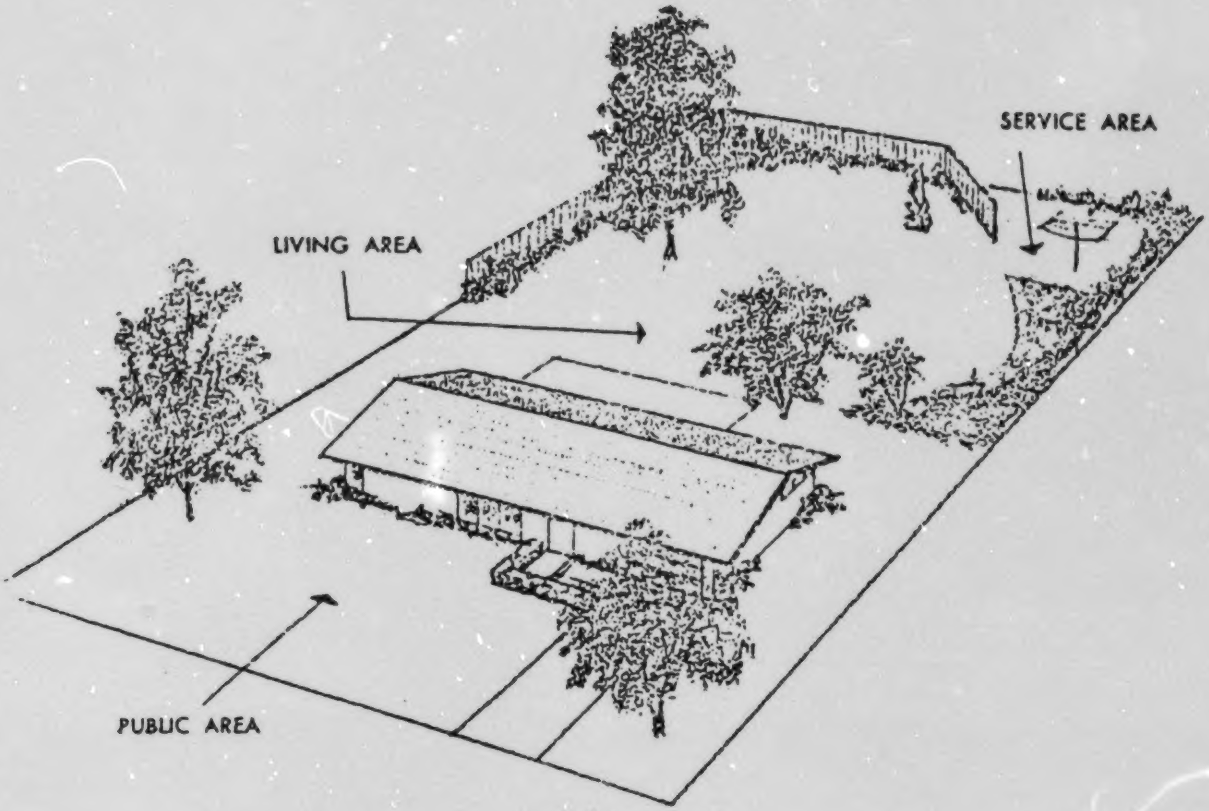


Fig. 14.--Landscape area.
(Source: Nelson)

Walks and Driveways

The public area should provide easy access to the carport, front entry, service entry, and private parking area. In general, plantings in this area should soften architectural building lines, frame the building with trees, and maintain open lawn areas. The area is also landscaped to help control climate.

The landscape design for the public area will be greatly affected by the location of structures such as walks and driveways. Walks and driveways must be located to provide means for easy entrance and exit from the property. Wide use of the automobile has influenced the placement of walks; people often enter a property through the driveway. For this reason, many walks are placed to lead to the main entrance from the driveway. This design feature avoids splitting of the public area into small sections.

All walks should be at or near ground level. They should not be more than an inch or two above the ground. A walk must be at least 4 feet wide so two people may use it at the same time. A drive should be at least 12 feet wide to allow passengers to alight on the paving. Walks and drives are straight unless there are obvious physical reasons for making them otherwise. Curved drives and walks should be avoided as they detract from the house or are out of scale. Figure 15 illustrates three methods of driveway placement.

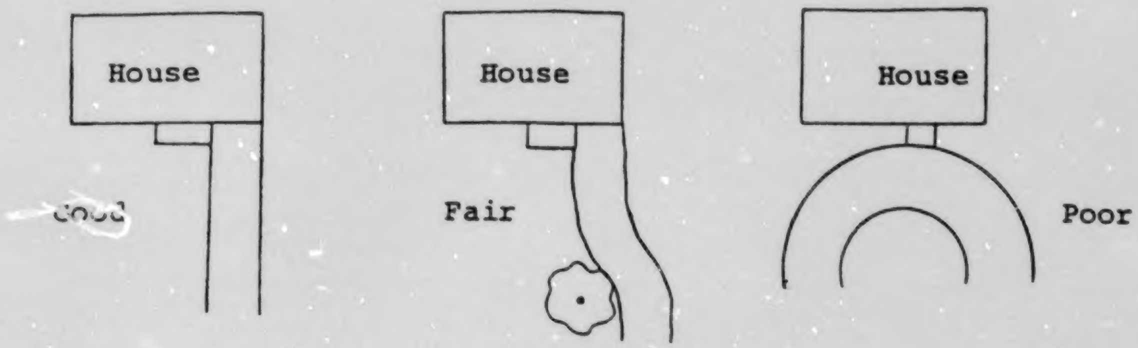
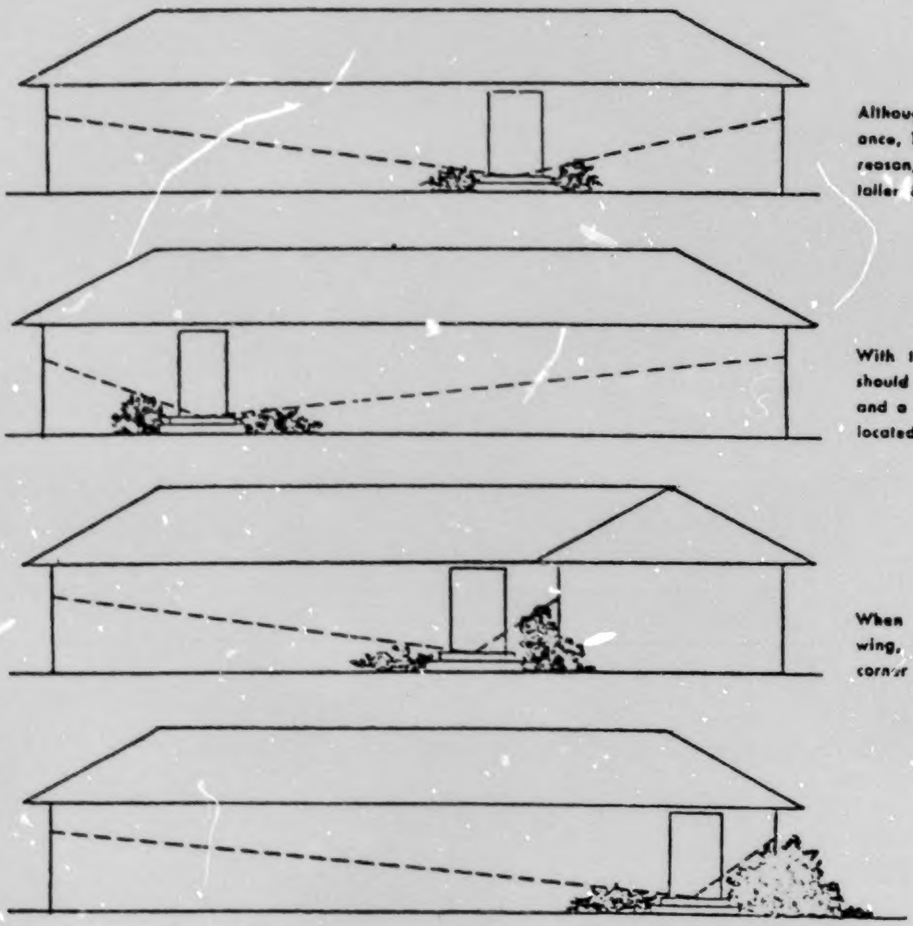


Fig. 15.--Walks and driveway should soften architectural lines of the house.

Focal Point

The center of interest and balance point for public areas are plantings near the front doorway. Window and door location, porch arrangement and other architectural features must be studied to arrive at a balance of all these elements when designing the landscape plan (see Figure 16).

An elevation sketch can be used to lay out the foundation plantings. Three points must be plotted on the sketch: one at the bottom center of the door, one at a point 2/3 of the distance up the right and left corners of the house. Two dotted lines join the dots on the corners with the dot at the door, forming a "V" pattern, thus directing the eye toward the door. Plantings do not extend above these lines. This emphasis upon one object is called "focus".



Although this house has almost true balance, it is slightly asymmetrical. For this reason, the plant on the right is a little taller than the one on the left.

With this door location, the taller plant should be located to the left of the door and a low-spreading evergreen should be located to the right.

When the door is close to a projecting wing, measure the guide line from the corner of the wing closest to the door.

When the door is very close to the corner of the house, the doorway planting and corner planting should be combined.

Fig. 16.--Center of interest and balance point of a building. (Source: Nelson)

Landscape Composition

Design for the public area should be simple for ease of maintenance and attractiveness. Good landscape composition around the house is composed of (1) a proper background, (2) a good enframement, (3) well-placed accents, and (4) an attractive foreground.

Background: A proper background, as shown in Figure 17, softens the silhouette of the house against the sky. Background trees give the appearance of nesting in the foliage. These trees are also used for shade.

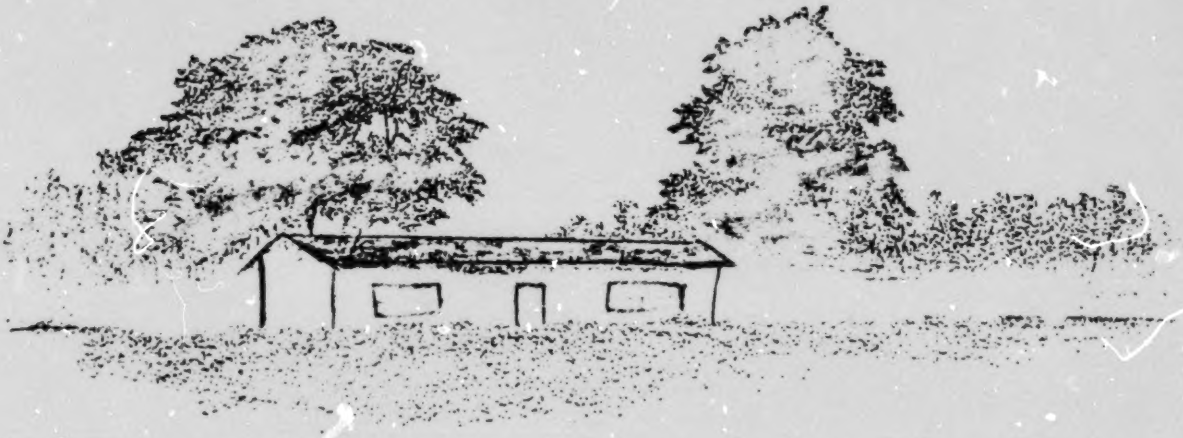


Fig. 17.--Proper background.
(Source: Nelson)

Enframement: Trees should be used to frame the home (refer to Figure 18). Framing the house concentrates the house from its surroundings just as a frame makes a picture more attractive. A large house needs a large frame. Small to medium-size diciduous trees, up to 35 feet in height, should be used for low ranch type houses or on smaller properties. For a small house, use large trees in rear as a background, and small to medium-sized trees in front.

Except in special cases, trees should not be planted in a straight line. Trees used for framing should be on a diagonal from the front corners of the house, to the sides and front of the house. Trees must not be on a line continuing from the base lines of the house. Trees for framing should be 20 feet or more from the house. Large trees too close to a house may loosen roofing, mar paint and clog gutters with leaves.

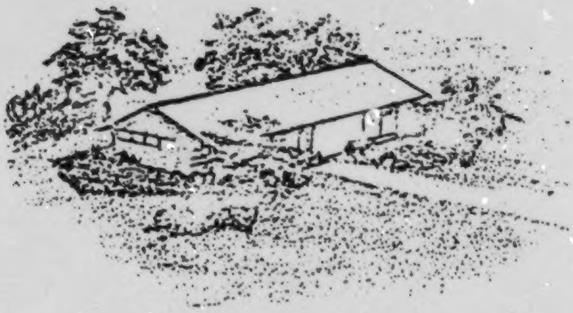


Fig. 18.--Framing the house with landscape material makes it more attractive.

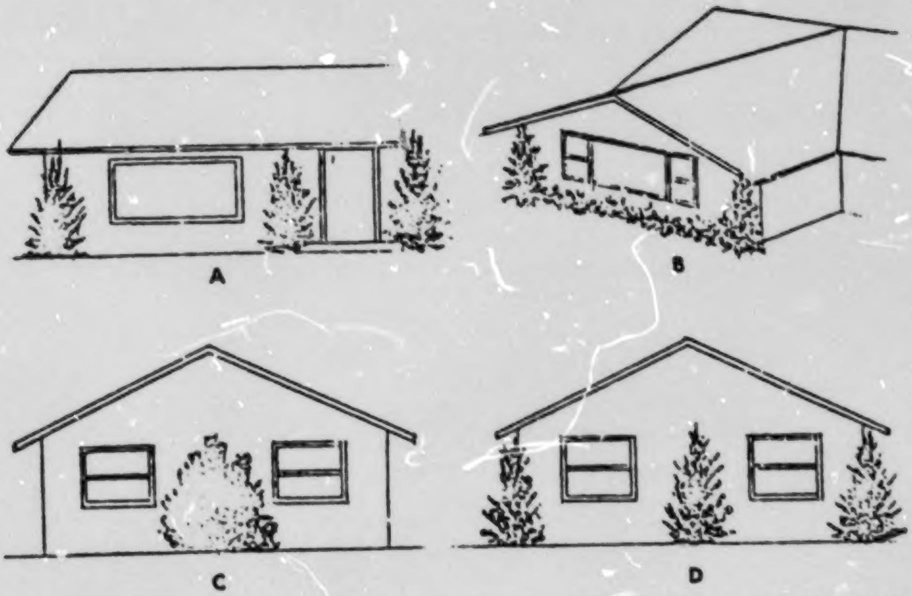
(Source: Nelson)

Well-placed accents: Good landscape composition around the house includes well-placed "accent" plants that draw attention to the important parts of the home. The front entrance should be the most attractive of the front foundation plantings. It is used to draw the eye toward the entrance and emphasizes the most attractive part of the front. Use of evergreens is better for this purpose than deciduous shrubs.

Attractive foreground: Plants are also used to draw attention away from unsightly parts of the house, such as high foundation, or a large front porch. These plants are referred to as "foundation plantings". They modify unpleasing proportions in the buildings, soften harsh corner lines of buildings and help blend the house with the ground. Figure 19 illustrates poor uses of foundation plantings.

There are several basic "rules-of-thumb" to follow in designing foundation plantings. The tallest shrubs are at the corners of the house and should not be higher than two-thirds the distance from the ground to the eave. Usually this will come to about the middle of the first floor window.

Plants at the entrance should not be higher than one-fourth to one-third the distance from the ground to the eave (see Figure 20). Low, rounded plants work well on both sides of the entrance; dense, slow-growing evergreens accomplish this purpose.



(A) DO NOT use conical and pyramidal evergreens at corners and doorways or to frame windows. These areas are already framed architecturally. Conical and pyramidal evergreens emphasize vertical lines and disrupt the scale relationship between the house and other plantings by growing too tall.

(B) DO NOT plant the projection of an L- or U-shaped house as a separate facade from the balance of the house. Elevation drawings are helpful in visualizing that the face of any projecting wing must be considered as being on the same plane as the other face areas of the house.

(C) DO NOT plant shrubs against every blank wall area, such as between windows at the side of the house. This type of planting tends to dwarf the house as well as to hide it.

(D) DO NOT plant upright evergreens or other plantings that divide an area into smaller parts. This makes the house appear tall and narrow.

Fig. 19.--Poor uses of foundation plantings.
(Source: Nelson)

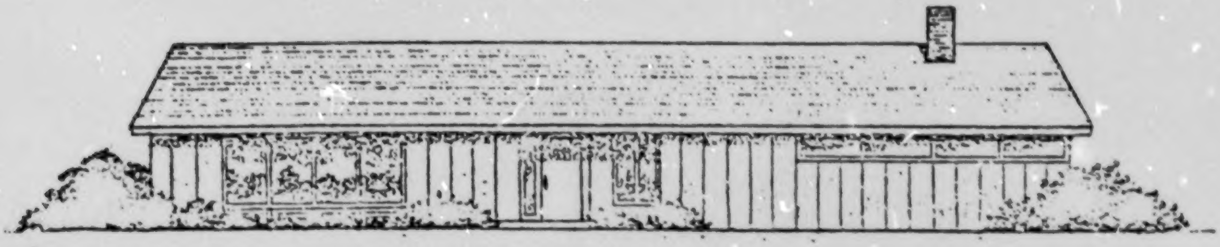


Fig. 20.--Correct plant height.
(Source: Nelson)

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The taller plants at the corners and lower plants at the entranceway form a concave line that directs the eye to the doorway. Plants too tall at the corner overemphasize the height of the building. Columnar plants at the corners tend to overemphasize vertical lines. If the house is a big stone type, round shaped plants should be used on the corners. Broad plants "hold down" a two-story house.

If the house is tall, narrow, and two-story, it can be made to look wider and lower by extending the foundation plantings adding plant "wings" to the building. These wing plantings "funnel" the view from the street toward the house and center it on the main entrance door. Deciduous and evergreen plants may be mixed for the corner plantings to provide interest in winter.

Foundation plantings do not cover picture windows. Shrubs planted under windows should be kept lower than the ledges of the window to avoid a overgrown look. Special attention should be paid to the mature height of the plants for this area. Many shrubs will soon cover the window.

If the picture window is extremely low, usually it is not a good idea to plant under it. Also, it is unnecessary to frame a large picture window with an upright evergreen on each side. The window already has all the framing it needs for good design. Framing a window with plants is like putting two frames around a picture.

One uses a variety of plants in the foundation planting. The best overall planting is made up of a combination of broad-leaf evergreens, needle-leaf evergreens, and deciduous shrubs. This combination provides for a variation of interest with seasonal changes. Deciduous shrubs should be rounded, horizontally branched. Figure 21 illustrates three different corner landscape plantings.

Every house is an individual problem. The planting should be planned to bring out the good features of the architecture and cover the bad. Appearance of a house can be greatly changed by the skillful use of plant material.

Planting along property lines is often discontinued at a point slightly in front of the front line of the house. This is particularly advantageous to adjoining property owners along town and city streets. Through this practice, privacy may be enjoyed in the major portion of the grounds and better views over wider expanses of lawn area are created, both from the street and the house.

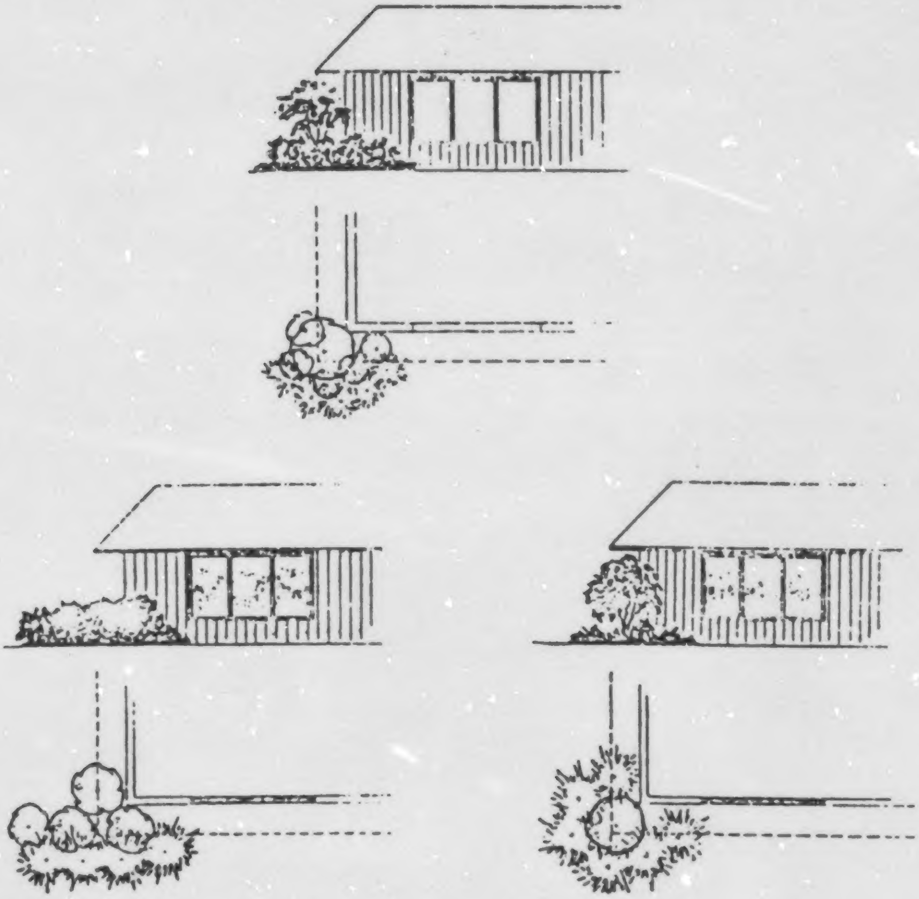


Fig. 21.--Corner plantings.
(Source: Nelson)

Public area plantings are intended to do several specific things in the landscape. They add beauty to the landscape, make a building blend into the surroundings, act as frames to emphasize important features, and screen unpleasant features. However, many times, common mistakes are made in the selection and placement of plant materials.

Spacing plants too closely together results in overplanting. This is a common fault in home landscaping. To avoid this mistake, a general rule of thumb is to allow for plenty of space between the plants, taking into account their rate of growth. Full mature growth of the materials planted must be considered prior to planting.

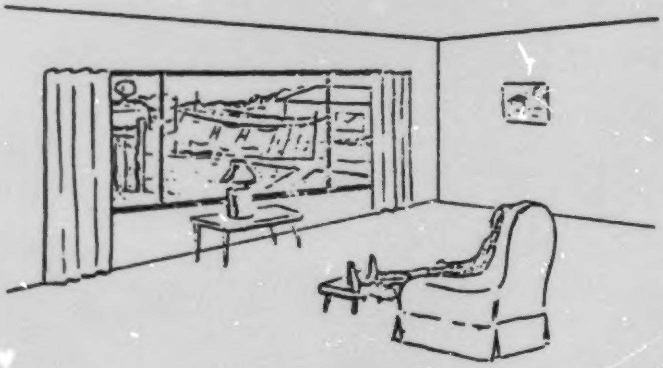
Planting too closely to buildings is also a mistake which can be avoided. Leave a minimum of 3 feet between the shrubs and the house on the older-style homes. For ranch type and more modern homes with extended overhangs, shrubs should be planted under the edge of the overhang.

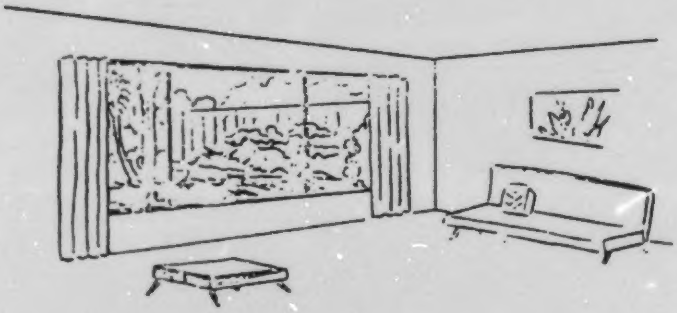
In other cases, using plants not suited to the buildings or unadapted to the local climate becomes a problem. Careful study and selection of plant materials helps alleviate this. Shape, fruit, flower, and foliage of the plant should accent textures and colors of the building materials of the house. Use plants to intensify the beauty of the house and grounds, rather than for their own individual beauty. Also select plants which are adapted to the local soil, light conditions (sun or shade), temperatures, and humidity. The selection of plant material is also dependent on the homeowner's finances and the amount of time he can spend on the landscape.

A tall shrub or tree may be made to look lower or "tied" to the ground by underplanting with lower, spreading shrubs. When grouping different height shrubs in a bed, place the taller growing species at the back. In a bed of more than one species, it is natural to place each species in informal subgroups, using odd numbers of plants (three, five, seven, etc.). Repeating small groups of a specie within a bed, or several beds close together creates "rhythm". Repetition "connects" parts of a bed or closely located beds together. This also give "unity" to the design with the guidelines holding true for grouping plants by form, color, or texture. Repeating a few species or types in one area of the landscape is better than using each species only once.

LANDSCAPING THE PRIVATE AREA

The private, or living, area has become an important part of the American home. This outdoor living space ought to provide for rest and relaxation and entertaining in reasonable privacy. No yard is too small for a private sitting area in which family and guests can enjoy the outdoors, away from public view. Such an area is usually located at the rear or at the side of the house. There should be an easy transition from house to outdoors, when possible. Having the living room open onto a porch or terrace, allowing access to the private yard, is the ideal arrangement.





Requirements for Outdoor Living

Included in the private area are patios, terraces, lawn, garden beds, outdoor eating facilities, children's play space, etc. Fences, hedges, and screens for privacy should enclose the region. The major requirements for outdoor living are privacy, a livable touch, year-round interest, climate control and design.

Privacy: In order to obtain privacy, an area needs to be hidden from the public and nearby neighbors. This can be provided with properly grouped shrubs and trees. Where the area is small, a fence will save space. The outdoor living area should be screened from work areas, such as clothes lines and other unslightly views, as well as from the neighbors.

Livable touch: Adding furniture to the outdoor living space gives a livable touch. This area is incomplete without furniture. The individual's tastes and live-style should be reflected in the transition from inside the house to the patio. Flowering plants also make an area still more inviting. The patio or terrace creates a feeling of living in harmony with nature.

Year-round interest: Plan the living area so the selection of plant material is varied and an interest is generated during the various seasons of the year. This is especially important when the private or living space is visible from the rooms of the house. Evergreen plants or plants with colorful bark and interesting branching patterns should be selected for the winter. During the rest of the seasons, flower, shrub, and tree selection is varied to create interest. Pools, stone steps, paving, walls, and other architectural features will add interest to the garden.

Climate control: Controlling climate in the private area helps to extend the length of time this area can be used. Shade trees screen sitting areas from the hot sun. Windbreaks reduce the wind, while garden pools provide a subtle cooling effect in the summer.

Design: The living area should be well-designed. All of the parts of the living area must blend together to form a pleasing picture that meets the landscape principles of unit, variety, harmony, and scale. Planning the living area on paper before starting to plant will develop this design.

Planning Considerations

The private area is studied carefully. From the house looking toward the boundary lines, certain neighboring areas may need to be screened while others may need to be accented. Next, the area is viewed toward the house to see if views from this position can be enhanced. The private area should be developed toward a dominant feature in the landscape. A dominant feature may be a distant view, an interesting rock formation, a specimen plant, or a combination of plantings and a fountain or sculpture. Existing desirable plant material is used in developing the private or living area.

Level, open-centered lawns prove to be most useful and practical for recreational purposes. Private areas should include open space for games. These open areas are also relaxing when viewed from the house or patio. Combinations of lawn areas with patterns of planting beds and buildings are attractive, inviting, and complement dominant features of the landscape. However, lawn areas should be free from scattered shrubs and ornamental structures that break up the area and increase maintenance.

Landscape patterns: Formal, or informal, landscape patterns may be used in the living area. Informal designs are usually appropriate, especially for houses with modern architectural lines. However, designers often combine aspects of both. Private areas are for parties, games, relaxation, and outdoor meals. Creations and feelings of privacy without impressions of confinement are worth the effort involved. Before private areas are designed, one must review the Analysis of Family Needs Check-List.

Patios: Most families desire a terrace or patio in the private area. Patios are designed as a connecting link between the house and surrounding area in which the private area is developed. Patios may be almost any shape, however, the most common ones are either rectangular, oval, square, or "L" shaped. Selections of patio materials, patterns, colors, and shapes allow the designer to express his/her ideas.

Patios often include raised planting beds, low walls and hedges, plant islands, crocks, and pottery, pools, and fountains. Formal or informal lines used in the patios are repeated in the planting beds and lawn borders.

Screening: Screening and enclosures for private areas are designed to control the view into and from the private area. Screening materials should be placed to provide enough privacy, avoiding harsh, cell-like enclosures. Also, screening materials give necessary control over the traffic of people and pets, and help to moderate wind, exposure, and noise. Both the type and amount of screening are limited to a large degree by neighboring property without loosing personal privacy. Views should be developed rather than screened. Planning will greatly "enlarge" the private area beyond its physical boundaries.

Neighbor's views: The backside of structures and plantings should always be attractive to nearby houses. When desirable, plan for gates or other openings for crossing into alleys and adjoining properties.

Planting beds: Planting beds are designed to complement the private area development, lawns, and patio patterns. These beds contain other features of interest to attract attention as the eye is led to a dominant feature at a distant point in the private area. In shallow private areas where it is hard to develop one dominant feature, these beds become the primary sources of interest. In such cases, special care must be taken to design the beds to be attractive and gain attention. All beds must be in harmony and unity with others in the private area.

Lawns: The open lawn area should not be destroyed with the use of several scattered plants. This rule also applies to the public area. A lawn area does not have to be square or rectangular to double as a play area. An informal design large enough to cover the needed square or rectangular size may be used. Table 1 lists game space requirements.

TABLE 1

Game Space Requirements

Game	Required Area
Croquet	30' x 60'
Badminton	24' x 54'
Volleyball	40' x 70'
Shuffleboard	10' x 52'
Horseshoes	10' x 50'

A few private areas may be too small for a lawn area. Where space is at a premium or in cases where maintenance would be difficult, it is often better to develop a paved courtyard with brick, stone, etc. Where space permits and a lawn is desired, the paved area should be in proportion to surrounding beds, lawn, and structures. Attention to scale and proportion keeps one element in the landscape from being "overpowered" by another. In the development of the private area, maintenance requirements of the lawn and plant materials must constantly be kept in mind.

In some cases, lawn areas may be greatly reduced by the use of swimming pools and pool decking. In these instances, other features of the landscape must be complementary to, and in harmony with, the pool. Swimming pools then become the main item of interest in the landscape.

LANDSCAPING THE SERVICE AREA

The service area provides space for services such as hauling of trash, clotheslines, animal pens, vegetable gardens, and storage. In some landscapes the children's play area is placed as part of the service area and in others, it becomes part of the private area. However, if the service area is used as a play area for small children, for safety reasons, it should be clearly visible from the kitchen or other work areas in which the mother spends most of her time.

The service area is usually located in back of the house, but may also be placed along one side. It should be convenient to the kitchen and laundry room. If possible, the driveway and garage or carport should be incorporated into this area. The location of facilities in the service area should be carefully planned. Walks should be planned to provide for easy access to and from the service area. They should be reasonably direct or curved only when necessary, and should be paved to avoid tracking mud and dirt into the house.

The area under clotheslines is often paved to allow easier movement of laundry carts; thus, eliminating the inconveniences of early morning dew and of soiling dropped clothes. The clothesline should be located where no one has to walk or play under it; however, the lines need plenty of sun and good air circulation.

Garbage and trash cans should be stored in such a manner to prevent the cans from overturning. In some cases, this will necessitate providing a rack or holder for the cans.

The only plants necessary in this area would be trees for shade or shrubs to screen the area from view. Service areas must be screened from the public and private areas. Both structural and plant materials are used for screening purpose.

SELECTING PLANT MATERIAL

Selecting the most suitable plant materials for a particular location requires great knowledge about plant species and their characteristics. Plants selected should be well suited to the needs of the site. Flowering, fruiting, foliage, and branching characteristics of the plant need to be studied along with its environmental adaptation. General information on plant materials that may be useful in their selection is located in the appendix of this student reference.

Classes of Landscape Plants

Landscape plants are divided into six (6) major classes based upon their use; namely, foundation, framing, groundcover, screen and and border, beds of color, and accent. When selecting plant material for landscaping purposes, the uses of these plants must be considered.

Foundation plants: Foundation plants are used to draw attention away from unsightly parts of a building. These plants are generally low profile plants that help blend the building with the ground.

Framing plants: Framing plants, generally trees, are used to frame a building much like a frame is used to make a picture more attractive. Sizes of the trees will vary depending upon the profile, shape, and size of the building.

Groundcovers: Plants used to cover bare areas on a landscape are commonly referred to as groundcovers. Groundcovers are of two types; namely, walk-on and non-walk-on. Walk-on covers include most turfgrasses such as bermudagrass, Dicondra, ryegrass, and St. Augustinegrass. Non-walk-on groundcovers include many vines and low profile evergreens and are usually not more than two (2) feet high.

Screen and border plants: Many private and service areas of landscapes are screened off from view by screen and border plants. These plants are higher than foundation plants and are used to enclose, or block off, private areas such as patios, outdoor eating areas, play areas, gardens, work areas, etc.

Beds of color: Beds of color are used to add beauty and color to the landscape. Flower beds can be planted throughout the landscape to enrich the visual beauty of the property. The color wheel, shown in Figure 22, is used to select flowers that are examples of the primary (red, yellow, blue) and secondary colors (orange, green, violet). The warm colors (red, orange, yellow) are closely related to one another, and are best suited in sequence.

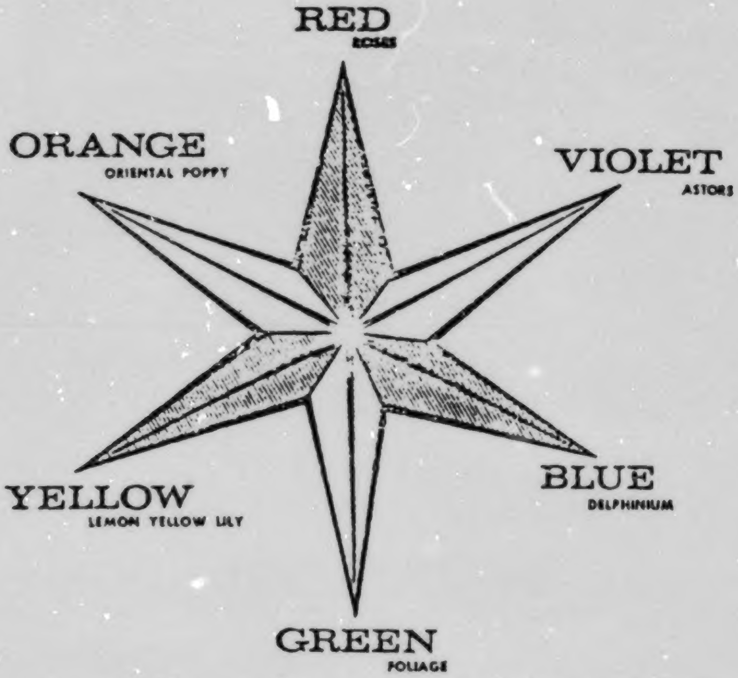


Fig. 22--Color star.
(Source: Nelson)

Cool colors (violet, blue, green) are used mostly to contrast the warm colors. Table 2 lists the color and variety of flowers at each desired height.

TABLE 2

Annual Flowers - Colors and Heights

Color	Height (Inches)			
	To 6	8-12	18-24	36 and above
White	Candytuft Lobelia Portulaca Sweet Alyssum Verbena	Garden Balsam Impatiens (shade) Dwarf Periwinkle Petunia Torenia (cool shade) Wax Begonia	Arctotis Bachelor Button Flowering Tobacco Larkspur Marigold (cream) Periwinkle Snapdragon Zinnia	Angel's Trumpet Cosmos Spiderflower Morning-glory "Pearly Gates" (Climber)
Yellow	Dahborg Daisy Pansy	California Poppy Marigold Nasturtium	Annual Chrysanthemum Calendula Gaillardia Iceland Poppy Marigold Snapdragon Zinnia	Nasturtium (vine) Plume Cockscomb "Golden Fleece"
Orange	Gazania Creeping Zinnia	California Poppy Cape Marigold Nasturtium Zinnia linearis	Annual Chrysanthemum Calendula Cireiosus Cosmos "Fiesta" Gaillardia Marigold Zinnia	Gloriosa Daisy Sunflower Tithonia "Torch"

TABLE 2 (continued)

Color	Height (Inches)			
	To 6	8-12	18-24	36 and above
Red and Pink	Annual Phlox "Scarlet Ball" Dianthus "Wee Willie" Sweet Alyssum "Rosie O'Day" Portulaca Verbena	California Poppy Celosia Dianthus "Double Daiety" "Sweet Wivelsfield" Fuchsia Garden Balsam Impatiens (shade) Nasturtium Dwarf Periwinkle Petunia Salvia "Fireball" Wax Begonia	Bachelor Button Basil "Dark Opal" (foliage) "Flowering" Kale (foliage) Flowering Tobacco Gaillardia Larkspur Marigold (bronze-red) Penstemon Salvia Scarlet Flax Snapdragon Vergena Zinnia	Annual Hollyhock Cosmos Mallow Plume Cockscomb "Forest Fire" Salvia
Violet	Gomphrena "Buddy" Lobelia Portulace Sweet Alyssum Verbena	Garden Balsam Petunia Torenia Violet	Heliotrope "Marine" Salvia "Violet Flame" Verbena Zinnia	Cosmos
Blue	Ageratum Lobelia Pansy Verbena	Browalia "Major Blue" Petunia	Annual Delphinium Bachelor Button Blue Laceflower Blue Salvia Larkspur	Morning-glory "Heavenly Blue" (Climber)
Spacing	4-6" apart	8-12" apart	12" apart	24" apart except climbers

(Source: Tate, Cooperative Extension Service Circulars 242 and 243)

Accent plants: Accent plants are used to draw attention to the important parts of a home or building. Accent plants, Figure 23, may include such special-effect plants as desert, bold foliage, strong vertical elements, colorful and woody plants.

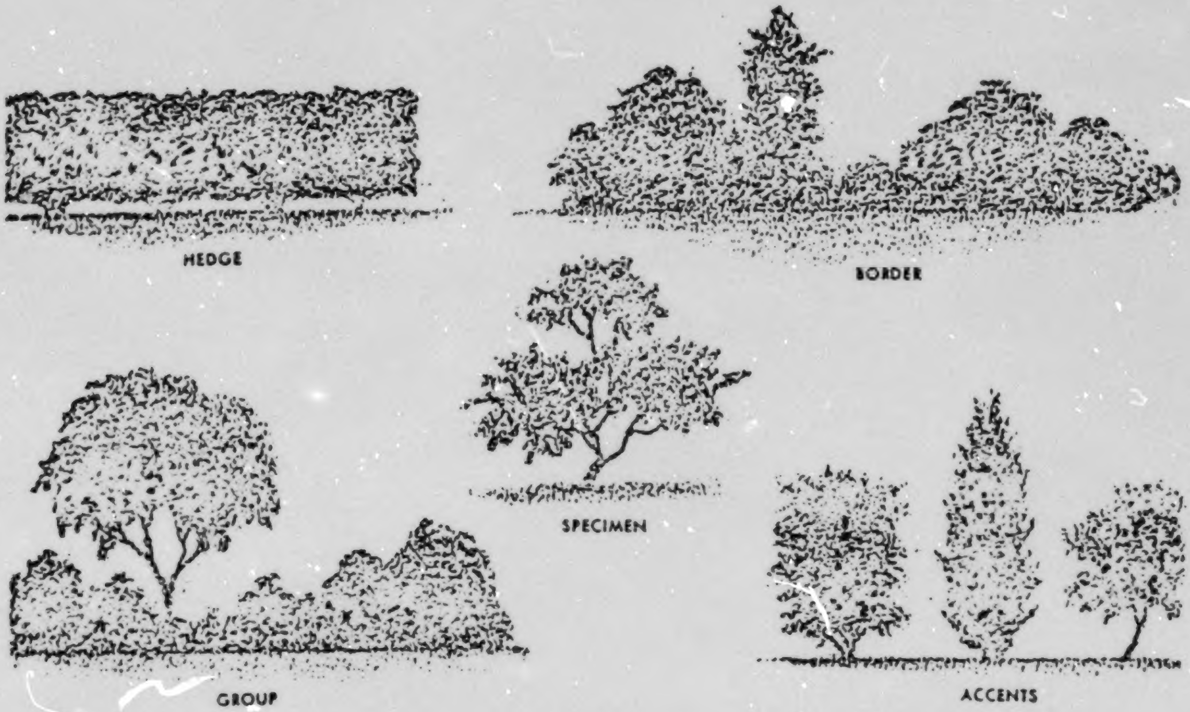


Fig. 23.--Accent plants.
(Source: Nelson)

Habit of Growth

Habit of growth refers to the size, form, and other growth characteristics of a plant, which is an important guide for plant selection. Generally, a plant has a vertical, horizontal, or rounded growth habit. A structure with horizontal lines may be contrasted by plants with vertical or rounded habits of growth and complemented by plants with horizontal habits of growth.

As illustrated in Figure 24, plant forms are columnar, rounded, vase-shaped, weeping, and oval. Low-growing plants are frequently placed under windows, along walks, or where a need exists for plant material that will not block vision. They may also be used for groundcovers. Plants with vertical growth habits may be used for screening, framing, shading, windbreaks and steep planting.

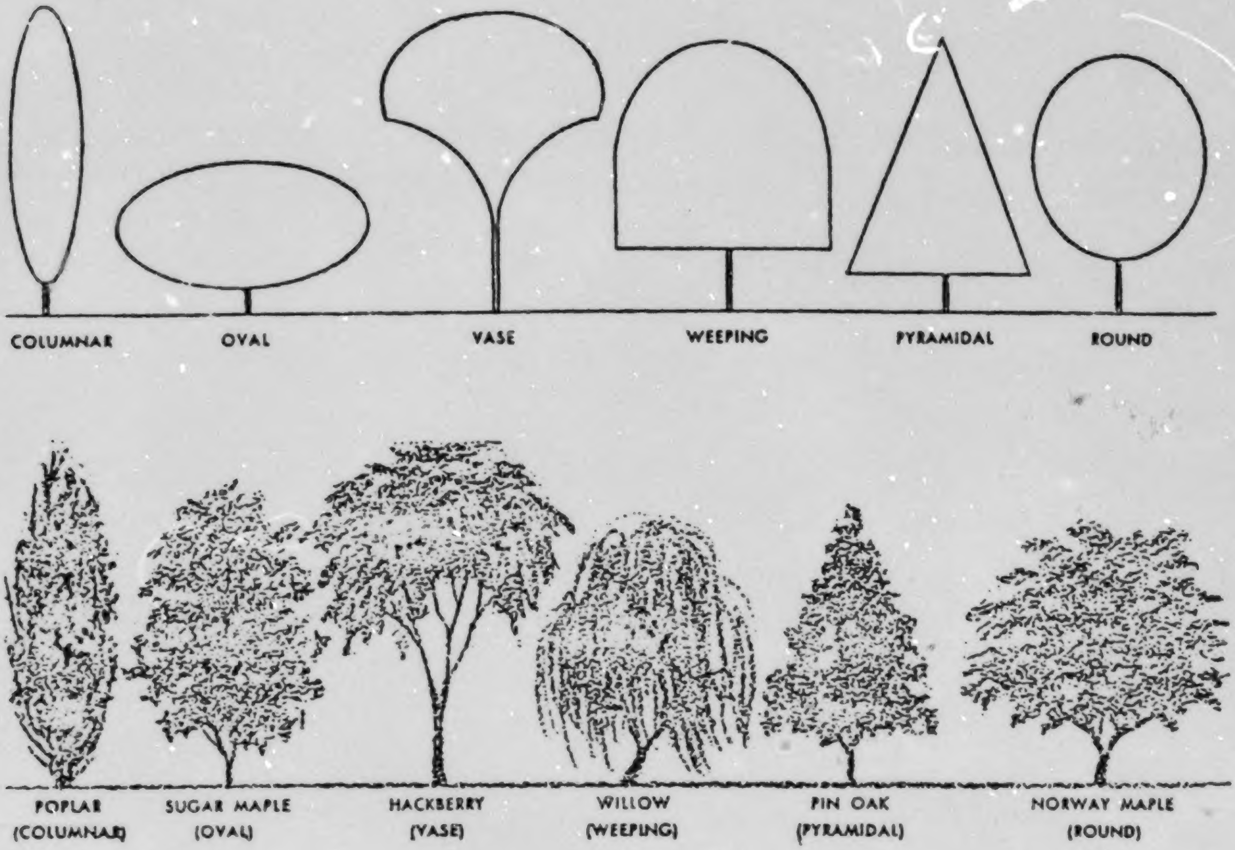

COLUMNAR
OVAL
VASE
WEEPING
PYRAMIDAL
ROUND
POPLAR (COLUMNAR)
SUGAR MAPLE (OVAL)
HACKBERRY (VASE)
WILLOW (WEEPING)
PIN OAK (PYRAMIDAL)
NORWAY MAPLE (ROUND)

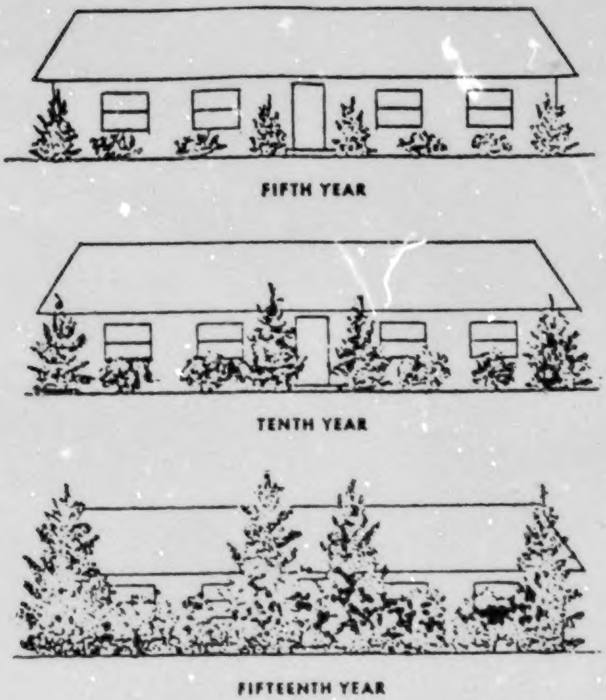
Fig. 24.--Plant forms

(Source: Nelson)

Some plants have intermediate habits of growth. They are useful for shrub borders, plant screens and hedges, specimen plantings and plantings close to the house. Growth habits of plants may be such that they are used for several purposes. Some evergreen species are used for windbreaks and for low growing hedges.

Mature Height and Shape

Always consider the mature height and shape when selecting a plant. It is best to decide on plants that will mature at the desired height and shape. A landscaper should visualize how the selected plants will look in five, ten, or fifteen years (see Figure 25). Plantings under windows or along the edges of drives and walks ought to have a mature height and width which does not obstruct vision or passage. Material chosen for framing and screening should have a mature height which is suitable for their planned use.



Know the mature height and spread of the plants you use. The "peek-a-boo" house (bottom drawing) shows the result of lack of information and planning.

Fig. 25.--Mature growth of plants.
(Source: Nelson)

Plant Hardiness

Plant adaptation or hardiness must also be considered. Only those plants which are considered hardy for the area should be selected. The amounts of rainfall, temperature extremes, humidity, and amount of sunshine all help to determine the hardiness zones for a plant.

Often a particularly desirable plant may be grown successfully just outside the limits of its zone by planting it in a protected area. Such protection provides a microclimate favorable for this particular plant.

Maintenance Requirements

Maintenance requirements for a landscape design must be considered at the time of planting. Landscape maintenance includes watering, pruning, fertilizing, staking, spraying, clipping, weeding, and other duties. Maintenance is reduced by selecting plant material which requires little pruning and is not highly susceptible to insects, disease, drought, and winter injury. Shrub plantings can be underplanted with groundcovers to simplify mowing. Semi-automatic watering can be installed. A low maintenance planting demands less of the owner's leisure time.

Other Considerations

The fruit, flower, foliage, and branching characteristics of plant materials in the landscape should blend into a harmonious relationship. It is usually better to plan a landscape with a few repeated colors or characteristics. A selection of plants giving the landscape a succession of color should be planned throughout the growing season.

Variety in the landscape may be obtained by varying the color, form, size, and texture. The most pleasing effect is obtained by having one form, color, size, or texture dominate. For example, it only one plant in a large planting is purple-leaved, while others are mid-green, interest is created without destroying the unifying effect of the green color. However, a planting of shrubs with equal proportions of red, blue, green, and yellow foliage is distracting. Similarly, a few pyramidal plants in a planting dominated by rounded forms creates interest without destroying the rounded forms.

Both evergreen and deciduous plant materials are used in landscape. Combinations of these plants increase interest and add individuality to the landscape. When combining these types, all masses and forms must be balanced. The appearance of the planting during the dormant season, as well as during the summer, must also be visualized.

The foliage of evergreen species can be enjoyed year-round with colors ranging from green to gray to blue. Leaves of evergreens may be fine-textured needles of junipers, medium-textured leaves of euonymous, or coarse-textured broad leaves of viburnum. Evergreens have many shapes as previously noted. Low spreading or upright conical forms are most frequently used.

Deciduous plants include a great variety of texture, flowering and fruiting habits, foliage and bark colors, and branching habits. They are often used to add color and interest to plantings. By proper selection, it is possible to achieve a succession of flowering from spring through summer and fall.

Trees usually have only one major trunk and grow upright, but multiple-trunked trees, such as an olive or mesquite "clump", are often used (see Figure 26). Deciduous trees are best suited for framing and shading. Evergreen trees are more effective for windbreaks and screens as they keep their foliage throughout the year. Selections of tree species depend on the space available, height needed, and use.

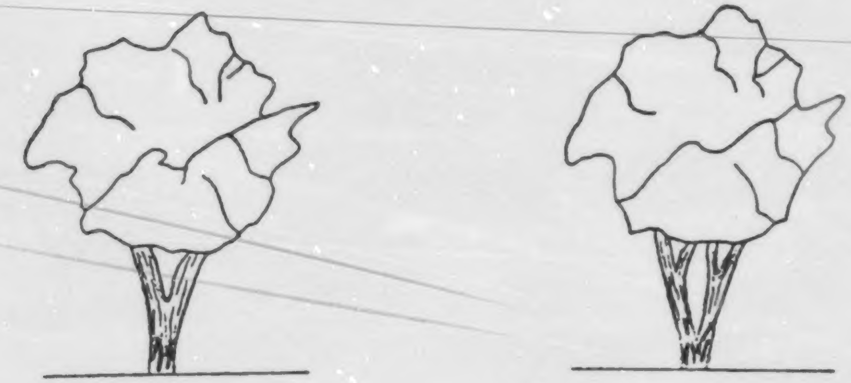


Fig. 26.--Single and multiple trunked trees.

Shrubs are characterized by their many stems. They may be evergreen or deciduous and have a wide variety of growth, flowering and fruiting habits. The planting distance between two shrubs usually equals their mature spread. Shrubs should be selected that will reach a desired height for the landscape when mature.

SUMMARY

With ample pre-planning, a landscape design can be developed which will satisfy the needs of the individual homeowner and the family. If certain approved practices are followed, the design may be both economical and enjoyable. Many "rules of thumb" and design principles have been presented in this publication. It is not the intent to answer all questions nor to solve all problems; however, basic concepts of landscape design have been presented herein which should aid the homeowner or beginning landscape architect.

Christmas Tree Production

Objectives:

Upon completion of this unit the student will be able to:

1. Determine the suitability of the soil and climate on their ranch/farm for Christmas Tree Production.
2. Appreciate labor requirements for producing Christmas Trees.
3. Plan roads for efficient use of labor.
4. Reduce competition through cultivation and/or spraying.
5. Shear trees correctly.
6. Choose a species of tree to grow.
7. Plant trees.
8. Protect trees from: fire, animals, insect and diseases, and soil deficiencies.
9. Know how and when to harvest trees.
10. Understand the marketing procedures for Christmas trees.
11. Grade trees.
12. Understand the laws and regulations for harvesting forest products.

References:

1. The following information is taken from "Pacific Northwest Extension Publication PNW6." This publication may be purchased from local Extension offices.
2. "Trees to Know in Oregon" - Extension Bulletin 697: OSU Extension Service or State Department of Forestry.
3. "Certified Tree Seeds and Seedlings" - Extension Circular 1050: OSU Extension Service.
4. "Christmas Trees in the Small Woodland" - Extension Circular 1099: OSU Extension Service.

5. "Developing High Quality True Fir Christmas Trees" - PNW 226: OSU Extension Service.

6. "Developing Sheared Douglas-Fir Christmas Trees" - PNW 227: OSU Extension Service.

7. "Northwest Lookout" - Published by the Northwest Christmas Tree Association.

Instructor Activities:

1. Secure copies of PNW 6 - "Growing Christmas Trees in the Pacific Northwest" for your class or copy the material provided here-in.

2. It is suggested that you use a local Christmas Tree Producer for discussion and demonstration of shearing, road layout, harvesting, and marketing.

3. Make use of the extension service Forestry Specialist if one is employed at your local Extension office.

4. Subscribe to the "Northwest Lookout" magazine (refer to References).

5. Plan a field trip to a local Christmas Tree Producer.

Student Activities:

1. Read materials.

2. Take notes.

3. Participate in discussion.

4. Shear trees.

5. Plan management system and feasability for a production project in Christmas Trees.

6. Field trip to visit a local Christmas Tree Producer.

SUBJECT MATTER OUTLINE:

I. Growing Christmas Trees in the Pacific Northwest

A. Introduction

Christmas trees are a deliberately planned, managed, and renewable farm crop. They are a big business in many areas of the Pacific Northwest. Each year about 5 million trees, mostly Douglas-fir are cut in Idaho, Oregon, and Washington. The sales value of this crop to the growers is an estimated 30 million dollars. Trees are shipped to markets in many states and in some foreign lands.

Today's trends are:

1. An emphasis on production of quality trees.
2. Increasing numbers of plantation-grown trees.
3. Decreasing numbers of uncultured natural trees--from 57 percent in 1959 to 10 percent in 1973.
4. Douglas-fir holding its place as the leading Christmas tree species in Washington, Oregon, Idaho, and Montana.
5. True firs being the second most popular Christmas trees.
6. Pine species being used decreasingly in plantations.

B. Consider Your Land

The physical conditions of the land in terms of its suitability for Christmas trees, plus the external forces surrounding it--climate, exposure, and air drainage--have a bearing on the success or failure of a Christmas tree enterprise.

Most Pacific Northwest Christmas trees come from forest lands that have been logged and have naturally reseeded. Such areas usually have conditions for growth that are favorable to the production of good-quality trees. Logged areas will continue to furnish many Christmas trees.

Cutting Christmas trees is not, as some people believe, a destructive practice. You can keep your lands fully stocked through quick replacement of cut trees.

Before entering the Christmas tree business, carefully consider your land quality and location, as well as the market situation. Not all tree lands will produce good Christmas trees. Not all people have the required interest, financial resources, or production capabilities to manage tree crops.

If you decide that your land has major advantages for the production of Christmas trees, the trees should be carefully managed.

C. Judge Your Opportunities

Whether you are thinking about managing natural Christmas tree land or starting a plantation, you need to consider all the factors involved--soil and climate, topography, location accessibility, protection, labor requirements, financing, harvesting, and marketing. Perhaps the most important point to consider is that only growers who can produce a high-quality product will be able to compete in the market place.

1. Soil and climate

Any soil easy to work--with good depth, open texture, medium fertility, good drainage, and not strongly acid nor alkaline--will usually grow good Christmas trees. Avoid soil extremes, such as coarse gravel and heavy clays.

The tree species you grow must be suited to the soil you have. Use the native trees as a guide when deciding what to plant. If they are desirable Christmas tree species and grow favorably, chances are you have the right combination of soil and climate.

Irrigation may be necessary in low-rainfall areas.

If you intend to plant introduced species, check their performance on neighboring plantations where conditions are quite similar.

The more varieties of Christmas tree species suited to the land, the more valuable the land is for raising Christmas trees. Select only species recommended for your location and those species that are in demand.

Soil grades run from poor to good in their capacity to produce Christmas trees. Most conifers do best on slightly acid soils. Few Christmas tree species will tolerate alkaline conditions. Generally, the least productive soils are thin and rocky or wet and poorly drained.

Try to avoid frost pockets and areas with poor air drainage. Late frosts often damage developing new growth. Almost all fir species are susceptible to frost damage; pine species are not. At the higher elevations, heavy snows often come early in the fall and remain late in the spring. This will seriously interfere with harvest and management operations. Don't try to grow Christmas trees where there are seasonal floods or drought.

It is risky to invest in large plantings of trees that are not native to an area unless the soil and climate conditions are favorable. If you plan to grow unusual or untested species, make a small trial planting first. Watch the growth and development for a period of time. Be sure that the trees are not unduly susceptible to insects and diseases in their new location.

2. Location

If you are purchasing land, be sure it meets all the requirements. Locating near market outlets will be a big advantage to you. Local retailing operations or shipping points for wholesalers should be close.

3. Accessibility

Good roads are important. They should be all-weather roads, since your most important operations are during bad-weather months. The soil that grows your Christmas trees must also support the network of harvest roads you use to take out your trees. If you raise your trees on fairly level land, your costs for layout and maintaining roads will be less.

4. Protection

Theft and fire are problems in the Christmas tree business. These can be reduced greatly if you have the right location. For example, if the main road to your woodland passes your house or farm bulidings, it is easier to control entrance and exit of people. Areas within rural fire districts have additional protection.

5. Labor requirements

Labor costs are a big expense. Social security, payroll taxes, and insurance must be paid, as well as wages.

All Christmas tree lands need work to increase the quantity and quality of trees. Unless you can do the job alone, you had better arrange for the necessary help beforehand. You will need labor in the rush season to help you cut and transport trees, solicit orders, and manage sales. And help is necessary during planting, shearing, and for other cultural tasks.

D. Managing Natural Stands

Christmas tree farming, like any other business, takes long-range planning. Ask your Extension agent for advice from the start.

In managing a natural Christmas tree area, you have to start as you find it. Your first decision is whether the best land use is for raising timber or Christmas trees.

Check the trees growing on the land. If the species is suitable and not beyond Christmas tree size, average distance between branch whorls is less than 14 inches, and most of the trees are dense, uniform, and a dark-green color, then your site probably is suitable to grow unsheared trees.

If the distance between branch whorls is more than 14 inches, the trees probably will benefit from annual shearing.

1. Plan the roads

You need an adequate network of harvest roads throughout your Christmas tree area. Lay these out with an eye toward permanence, and be sure that they are passable the year around. Often the roads can be planned so that they will also serve as fire breaks. Fit existing woods roads into your permanent road plan as much as possible. Build new roads as needed to open the area for harvest and protection.

Lay out the roads on the contour to avoid steep grades. In the long run, a well-laid-out road system will more than pay for itself in reduced road upkeep costs, harvesting efficiency, and savings on transportation equipment repair.

2. Use cultural practices

An experienced tree farmer says, "Farming Christmas trees consists generally of removing vegetative competition and building quality into the trees by systematic thinning, pruning, and shearing."

Every job that you do to improve the number and quality of Christmas trees is a cultural practice. You will practice some or all of them if you stay in the business very long, whether you manage natural tree lands or establish a plantation.

Natural tree lands vary in competition more than plantations, and therefore vary in their needs for cultural practices. Natural tree lands usually contain trees of different ages, including seedlings, saplings, and poles. The trees grow singly or in dense patches. Some spots may be barren of trees.

Tools commonly used in cultural practices are the light chain saw, double-bitted ax, machete, hand pruners, hedge shears, and shearing knife.

3. Reduce competing growth

Bushy, well-formed, well-colored trees can develop only where there is enough room to grow in all directions. Trees grown in hardwood brush usually have lower branches that need to be pruned off to a point above the brush to make good trees. Controlling the brush allows the trees to develop uniformly and close to the ground. It also permits natural reseeding and encourages faster growth because the trees do not need to grow through and out of the brush. Hardwood brush is most persistent on fast-growth sites.

All undesirable hardwood and coniferous growth in the Christmas tree areas should be cut down. The cut trees should be stripped of branches so that they will lie close to the ground and rot quickly. Dead trees with limbs make it difficult to get around the area and also deform small Christmas trees that may be growing nearby.

Grass is also competitive, and will need to be controlled--especially in low-rainfall areas.

4. Thin excess trees

Christmas trees spaced too closely interfere with each other's growth. For instance, when two trees grow too closely together and their branches overlap, those branches do not grow as fast as branches on the open side, and neither tree grows symmetrically.

Beginners almost always keep too many trees. At Christmas tree size, not more than 2,000 well-spaced trees per acre can grown unhampered. Cut out the excess trees so that the remaining trees have ample room to grow in all directions. An average spacing of about 5 feet between trees of near marketable size is adequate.

The first step in a densely stocked natural stand is to harvest in the first cutting as many salable trees as possible. If the remaining trees are still crowded, cut enough other trees to provide ample space for growth. Try to visualize the room needed for each tree to develop to Christmas tree size without interference from adjoining trees.

Some growers leave several tall trees as seed source for future crops. Keep at least two well-spaced seed trees with genetically acceptable traits per acre when you rely on natural seeding to reproduce a crop.

Except for the seed trees, most growers limit tree size to not more than 10 feet. The size depends on the market, but the most popular tree sizes are from 5 to 8 feet.

5. Shear

Shearing, the practice of cutting the leader and lateral branches to improve shape and density, will:

a. Increase density by encouraging growth of branches.

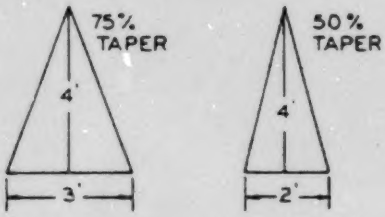
b. Control excessive growth of Christmas trees located on fast-growth sites.

c. Produce more salable trees per acre by salvaging trees that would not otherwise be salable.

Shearing is done with either a shearing knife or a power trimmer. Shearing crews also often carry hand pruners for hard-to-get-to places. A few seconds' work with hand pruners on difficult terminal whorls will assure an improved tree. Another tool that may be used increasingly is the power-operated, lightweight sickle bar clippers.

Douglas-fir shearing can be done any time after budset in mid-summer and before bud burst in April. A tree should be sheared when the usable height attains about 5 feet. The leader should be trimmed back to good proportion just above an internodal bud. At the same time, the side branches should be sheared back to form a 40 to 60 percent cone. A 60 percent cone is when the width is 60 percent of the height. This process is repeated each year until the tree is ready for harvest.

Grand fir, and to a lesser extent concolor fir, can be sheared like Douglas-fir or left unsheared. However, noble fir and Shasta red fir make better-quality trees if they can be grown without heavy shearing.



Whenever possible, leader growth of the noble fir and Shasta red fir should be controlled by shock treatments such as basal pruning, leader scarring, or pruning. If it is necessary to shear to correct lopsided shape or excessive width, the fork shearing method is recommended. This consists of cutting the tips of main lateral branches just above a pair of secondary buds or branchlets for desired shape and taper. The crook or "dog-leg" resulting from cutting the leader can be reduced by shearing during the succulent stage.

Unlike firs, pines should be sheared only when succulent. Shearing should begin when needles on the new shoots are about half as long as the last year's needles. Thereafter, shearing may be continued for about 30 days for scotch pine, but only about 10 days for shore pine, western white pine, and Austrian pine, which do not form buds as readily as the scotch pine.

About 60 days after succulent shearing, the cut leader and branch tips will form new buds for next year's growth. This budding characteristic makes pine the easiest of all trees to shape--if the shearing is done at the right time. Sheared pines should be shaped to a 40 to 60 percent cone.

6. Basal pruning is the removal of unwanted branches below a selected good bottom whorl. This type of pruning will:

   a. Reduce rate of growth when more than one-third of the live crown is removed. (Removal of more than 60 percent of the crown usually results in serious slowdown of growth and perhaps yellowing of the foliage for a year or longer.)

   b. Determine usable portion of the crown.

   c. Strengthen branch structure and increase needle density.

   d. Create a smooth, clean, knot-free handle.

   When basal pruning, select a bottom whorl with four or more strong, evenly spaced branches. This is usually the first good whorl above the general level of the ferns and other brushy ground cover--about 12 to 24 inches from the ground. Remove all unwanted branches below the whorl with a hand pruner, short-handled pruning saw, or short machete.

   Delay basal pruning until not more than one-third of the total foliage on the tree will be cut off. This will prevent excessive shock, which causes delayed development of the trees.

7. Practice stump culture

   Stump culture is the practice of allowing a whorl of limbs to remain on the stump of a cut tree so that a new tree will develop.

   The stump should be as close to the ground as possible. Cut back the branch whorl at least half its length to encourage sprout formation on the stump. Such sprouts will form complete whorls faster than an upturned branch. Select the strongest, best-located sprout for the new tree--it will develop faster. Remove the other branches and surplus sprouts gradually over a couple of years as a safeguard against excess shock.

Stump culture is most practical where trees are scattered and natural reproduction is limited by poor, dry soil.

Most growers do not use stump culture where natural seedlings are plentiful. The most important advantage of stump cultures is that there is a strong established root system to support the second tree.

E. Managing Plantations

Christmas tree plantations are usually established on tillable ground formerly used for agricultural purposes. Although many fine Christmas trees are produced from fields, it is not fact that fields grow good trees per se. For many fields a high level of intensive management is required to produce a quality product. Many existing plantations develop troubles due to low fertility, poor water or air drainage, rocky soils, or inadequate soil preparation.

Ideal plantation land is fertile enough to provide a vigorous growth rate. Except for noble and Shasta fir, growth rate can be much greater than what is needed for normal development of Christmas trees. Desired quality in the trees is attained by shearing excess growth.

If growers already own the land, they must determine the suitability of each field for the species they intend to grow. If a careful analysis shows that the land is unsuitable, the grower should either drop the project or purchase land that is suited for growing Christmas trees. When growers think they have located suitable acreage they should check it out with the help of their county Extension agent and successful growers before purchasing.

The question may arise as to how large an operation should be contemplated. It depends on the time and capital available. The next question is "What is a full-time operation for one person?" The answer to this is that one person should be able to manage 80 acres of Christmas trees, except for short peak periods in shearing and harvesting. It may be difficult, economically, to justify farming a small acreage when considering amortization of labor-saving equipment and assuring buyers of an adequate volume of trees over a period of time.

1. Choosing your species

Consumer demand, geographic location, soil, and climate determine which species you can grow most profitably. Plantations have been established for at least 10 years in most Christmas tree areas. Growers have had the opportunity to plant improved species or strains and evaluate results. When starting a plantation, therefore, new growers should first check out existing plantings, and discuss selection of species with an Extension agent, or state service forester.

Except in isolated areas, very little success has been encountered in quantity planting of the following species:

Austrian pine
Bishop pine
Norway spruce
Blue spruce
Giant sequoia
Western white pine
Lodgepole pine
Concolor fir

The principle Christmas tree species that are recommended for planting in the north Pacific area are:

Douglas-fir
Scotch and shore pine
Grand fir
Noble fir and Shasta red fir (recommended only
 for western Oregon and Washington)

a. The true firs (*Abies*), because of their characteristic uniform branching and formal appearance, usually command the best price on the market. However, they develop slowly and require intentive management. Many true firs are high-altitude trees and have been established successfully in only a few plantations at lower elevations. Shasta red fir (*Abies magnifica* vars. *shastensis*) and noble fir (*Abies procera*) are two examples. They are not recommended in areas east of the Cascade Mountains. West of the Cascades, noble fir does well in only a few places, usually at a higher elevation. Rotation period for these species varies from 8 to 14 years.

b. Grand fir (*Abies grandis*) grows naturally in widely distributed areas of the Pacific Northwest. It is well liked and widely used in many areas. Of all the true firs, it is usually the most easily grown in plantations. In recent grand fir provenance tests (relocating trees from area of origin), seed sources from Grangeville, Idaho; Pend Orielle, Idaho; Pomeroy, Washington; and McCall, Idaho, proved to be the best.

c. Douglas-fir (Pseudotsuga menziesii) is a Pacific Northwest species that is well suited for both timber and Christmas trees. It grows naturally on a wide variety of soils under great climatic variations. However, plantings in northern Idaho have had a great deal of trouble from frost damage, Douglas-fir needle blight, and the Douglas-fir needle midge. Oregon has also experienced these problems. They can be avoided by planting the Vancouver Island (Duncan), Shelton (Cushman) or medium-elevation coastal strains (Valley slopes). These strains exhibit late bud burst, which avoids the frost season and the main midge attacks.

d. Scotch pine (Pinus sylvestris) is a native of Europe, but is widely used for Christmas trees in the United States. The varieties to use are the Spanish quandarrama mountain strain and the Spanish burga. Another strain that usually has performed satisfactorily is the French Auv'ergne. The Spanish strains have short, blue-green needles that do not turn yellow in winter and have good natural form. They respond well to shearing and will grow well on a variety of sites. Scotch pine probably is the only choice for wet areas.

e. Lodgepole pine (Pinus contorta) the Cascade variety is not recommended because of its light branching habit and erratic response to shaping. Shore pine, a coastal variety of lodgepole, plays a limited role in west side plantations. The only recommended seed sources of shore pine is within one mile of the Pacific Coast from Port Orford, Oregon, south to Crescent City, California. This tree has luxurious, short, dark green needles. Like Scotch pine, shore pine responds well to shearing.

f. Austrian pine (Pinus nigra), like Scotch pine, is a native of Europe and has many geographic strains. It has stiff needles and rigid branches suitable for flocking. Only a limited number of this species has been planted because of poor color and shearing response. This picture may change in years to come if suitable strains are identified in Oregon-Washington provenance-test plantings. Countries represented in the plantings are Austria, France, Yugoslavia, Greece, Turkey, and Russia.

g. Norway spruce (Picea abis) is another native of Europe that has been planted on a variety of sites in the Pacific Northwest. It has a moderate growth rate and responds well to shearing. The foliage is an attractive blue-green, composed of short, stiff, prickly needles. Major drawbacks are poor needle retention and susceptibility to spider mite.

h. Western white pine (Pinus monticola) is a native of parts of the Pacific Northwest. The tree has medium-length, soft blue-green needles. It has a moderate growth rate and responds well to shearing. Disadvantages are its light branch structure and extreme susceptibility to the European white pine blister rust.

2. Getting planting stock

The main sources of Christmas tree planting stock vary from state to state. For specific information about seedlings available from public and commercial nurseries, consult your Extension agent or a neighboring grower. Always buy planting stock from proved seed sources of good quality.

3. Preparing the land

Seedlings do poorly or may not survive at all if they are planted in grass and weeds or in grass and weeds or in infertile or heavy soils. For successful planting, seedlings should be treated similarly to household shrubs. Soil preparation is important before planting and for soil management afterwards. Plow deeply, disk, and harrow. Subsoiling may be needed where previous shallow plowing was the rule. Planting 8- to 10-inch root systems is quite different from sowing wheat or barley, so take care to establish the roots properly.

Drylands of eastern Washington, Oregon and Idaho, and areas covered with heavy sod should be plowed in the fall or spring and summer fallowed. Where neither moisture nor sod are problems, plow in the fall or early winter. Disk or harrow immediately before planting in the spring. After planting, control weeds with herbicides.

Planting can be done on stump lands where cultivation is not possible. Prepare the site by piling and burning debris and scalping sod off of 3-foot-diameter spots where trees will be planted. Follow up with a herbicide to keep scalped spots weed-free.

4. Laying out the roads

A well-laid-out road system will reduce harvest costs and speed up every plantation operation from planting to harvest. Roads can be provided by skipping the planting of two adjacent rows every 400 feet. The road system will serve as a fire break as well as for access.

Plantation roads are a permanent investment, the costs of which will be charged against several crops. You can reduce costs (and greatly increase profits) by carefully planning the road layout when you prepare the land for planting. It is far more efficient to lay out roads before planting than afterwards.

5. Planting the trees

West of the Cascades, February 1 to May 1 is the best planting time. East of the Cascades, early spring planting is recommended.

The dormant season lasts from late autumn, after the hardwood leaves have fallen, until the new growth starts in the spring. Plant only during the dormant season, when the soil is moist and workable. In general, the less time there is between planting the trees and their breaking dormancy, the more chance they have for survival. Fall-planted trees must endure all the winter hardships before the growing season begins. Frost heaving can be a real danger for fall-planted trees, except where deep snows cover the ground all winter. In mild climates at low elevations, you can plant during the entire dormant period if there is enough soil moisture. At higher elevations, where deep snow stays on the ground until early summer, fall planting is a must.

Cool, humid weather is ideal for planting. In such weather, the trees are unlikely to dry out during and after planting. Also, the ground is easy to work and in good condition for planting operations. Weather permitting, the month of March is ideal for planting trees in western Oregon and Washington. Growers who plant or replace trees by hand usually can get started earlier than those who machine-plant. Although a field may have been worked the previous year, final shallow disking and harrowing is necessary just before planting by machine. When planting by machine, the soil must be friable and flow easily into the planting slit.

6. Planting tools and machines

There are two kinds of tools available--hand tools and planting machines. The kind of tool to use is determined by the condition of the planting site, tools available, size of the job, size of trees to be planted, and the costs.

Types of hand tools are: planting bar, round-pointed shovel, and planting hoe.

The planting bar is commonly used for small plantings and is one of the most popular hand tools. It has a heavy, tapered blade 3 inches wide and 10 inches long, attached to a round handle 30 inches long. To use a planting bar make a slit in the ground by stepping on the footrest of the blade and pressing the blade into the ground. Then, pull back on the handle to open the slit and insert the tree. While holding the tree at the right depth in the soil, pull the planting bar out of the slit and reinsert 3 or 4 inches back from the first slit. Push the handle forward to push the soil back against the tree. A backward pull on the handle will make sure that the soil is pressed against the roots at the bottom of the hole. In the deep, loose soil found on some planting sites, the planting bar works very well. Where it can be used, it will speed up the planting of the small trees.

The round-pointed shovel is better than the planting bar for planting large-rooted trees. It can be used much the same way as the planting bar.

The planting hoe is more popular for wildland planting than field planting. It is a short-handled, long-bladed, grub hoe.

The soil auger, or post-hole digger, is another tool often used to dig holes for trees. These augers are often attachments to chain saws. They work well in soil that is free of rocks and roots. Since the removed soil is scattered and often mixed with debris, however, good fill dirt often is scarce.

There are two main kinds of tree planting machines. One is mounted on a tractor's hydraulic system; the other is drawn behind a tractor. These are manufactured under various trade names. Other machines have been adapted from old plows, subsoilers, and vegetable transplanters. The planting machine colter and shoe opens a trench or slit in the ground. The trees are set into the opening, and two packing wheels, set at an angle, follow and press the soil back against the roots.

7. How to plant

Planting young trees is a simple operation, but it must be done carefully to be successful. Here are the important points to remember:

a. Plant during cool, humid weather, if possible.

b. Keep the roots covered and moist at all times. When planting by hand, carry the trees in a canvas bag or bucket with the roots covered by wet moss or shavings.

c. Set the tree upright in a hole or slit large enough to hold the roots without crumpling or bending them. Spread the roots out in as natural a position as possible.

d. Plant neither too deep nor too shallow. The planted trees should have all their roots well covered. Set the tree at the same depth or about ½-inch deeper than it was growing in the nursery. A color change on the stem above the root system marks the former soil line. This is known as the root collar--it can be used as a marker for setting the tree to the right depth. When the root collar is set not more than ½-inch under the surface, it will be at the ground line when the fill soil settles around the roots.

e. Use loose, moist, crumbly soil to cover the roots. Spread the roots in as natural a position as possible. Tamp the soil well around the newly planted tree for close contact between soil and roots and to eliminate air pockets.

f. Check to see if the tree will resist a slight pull. It should feel solidly fastened in the ground. A correctly planted tree will never pull out of the ground easily.

g. Water the newly planted trees if there are droughty conditions or soil seems dry. Where rainfall is under 24 inches a year, seasonal irrigation is desirable to help establish the trees and carry them through the first one or two dry summers. Get the advice of Extension agents or forestry specialists before planting a Christmas tree crop in such areas.

When you plant trees where rainfall is less than 24 inches a year, settle the roots with water at planting time and irrigate during the summer months. Furrow irrigation is preferred to sprinkling. A periodic good soaking is much better than frequent light watering. The object of irrigation is to provide enough water to keep the tree healthy and yet force it to extend its roots down to any available underground moisture.

Number of Trees Per Acre at Various Spacings

Spacing	Planted solid	After 10 percent reduction for roads
4½ x 4½ feet	2,151	1,936
5 x 5 feet	1,742	1,568
5 x 6 feet	1,452	1,307
5½ x 5½ feet	1,440	1,296
5½ x 6 feet	1,320	1,188
6 x 6 feet	1,210	1,089
6½ x 6½ feet	1,031	928

Use a spacing of 4 by 4 feet or less only when you have a market for small trees. If most of your trees will go as 6-footers, a spacing of 5½ by 5½ feet will be adequate.

After planting, inspect the trees periodically for indications of damage. Plan on a 10 percent loss of each species when ordering the trees, and increase orders by this amount to provide for normal replacement needs. The extra trees can be transplanted and be growing and gaining in size in a garden row until they are needed as replacements.

8. Culturing plantation trees

During the first 2 years after planting, concentrate on replacing losses, cutting out multiple leaders, and keeping the area free of any grass or weeds that develop. For the majority of plantations, cultural activity starts in earnest after the third growing season. At this point excessively long leaders should be cut back and sides sheared to 40 to 60 percent taper. Basal pruning can also be done at this time to form a handle, providing not more than one-third of the foliage is removed.

Grow your seedlings in a relatively noncompetitive environment through the use of herbicides or cultivation, but at the same time take any steps necessary to control soil erosion. Protection from insects, diseases, animals, and other destructive agents is also essential for good survival and growth. For additional information on other cultural practices, refer to the section on Managing Natural Stands.

F. Protection

Protecting trees can be a troublesome and costly part of any Christmas tree venture. Theft of mature trees is a common risk. Fire, insects, diseases, and animal damage are other problems.

1. Fire

Fire protection is a year-round concern of the Christmas tree producer. Some Christmas tree acreages can become susceptible to burning any month of the year. Light fuels, such as dead ferns or grasses will dry out between rainy spells and are a fire hazard. Caution signs have value, but more positive steps are recommended.

Christmas tree areas near principal highways, housing developments, railroads, or other situations that increase fire risk definitely need fire lanes for protection. Adequate fire lanes bordering plantations, plus interior ones if needed, are a good investment. Fire lanes should be located so that fires can be reached and controlled with a minimum of lost time. Primary road systems can be planned to serve as fire lanes.

Fire lanes can vary from 6 to 15 feet or more in width. Keep them clean by plowing, disking, or by using herbicides. Interior lanes will vary in number and width according to location. Omitting two rows of trees about every 400 feet provides fire lanes as well as access roads.

Some fire tools and other equipment should be available at a Christmas tree plantation at all times. Some growers also construct ponds or water holes so that a dependable supply of water is available in case of a fire.

"No smoking" except in designated area, should be enforced during periods of high fire danger.

Posting Christmas tree areas and closing access to them will discourage trespass and may prevent some fires. Responsible individuals should be told that emergency entry for fire suppression is authorized.

2. Trespass

Trespass is unlawful entry or theft of trees. It is a problem which can best be solved by cooperating with law enforcement officers and local residents. The problem is less troublesome when the trees are growing on your home property and can be watched. Theft can be controlled somewhat by using barbed wire fences, locked gates, and signs. In problem areas, special fencing or a hired guard may be the answer.

3. Animals

Livestock and Christmas trees don't mix. Protection from grazing animals is as important as fire protection. Cows, sheep, horses, and goats should be kept out of the production area at all times. If this is impossible it is better to defer Christmas tree farming.

Livestock cause damage by browsing, rubbing, and trampling trees and make it impossible to grow a salable crop. A good fence around the Christmas tree area is the best defense against livestock.

Deer are especially troublesome when plantations are located next to extensive forested areas. During the early growing season, deer (and sometimes elk) will supplement their diet with tender, succulent fir tips. Deer also scrape off bark and break branches by rubbing trees with their antlers. If deer have become a threat to your Christmas tree operation ask the State Game Department for assistance.

Several effective repellents are available, but need to be applied repeatedly to prevent browsing. Keeping grass entirely out of the Christmas tree area is perhaps the most effective way to prevent animal damage.

Other serious mammalian pests are mice, rabbits, mountain beaver, moles, gophers, and squirrels. Meadow mice and rabbits are particularly troublesome. Injury occurs mainly during the winter months and consists of girdling or cutting the stem at and above the ground line. East of the Cascades, gophers are a serious problem. Often adjacent properties must be treated as well as the plantation.

The most effective control is to maintain an unfavorable habitat by removing grass and weeds from the field. Another approach is to protect natural predators such as foxes, coyotes, owls, and hawks. Baiting and trapping may also substantially reduce many of the rodent pests.

4. Soil deficiencies

A soil analysis is recommended to pinpoint deficiencies. Lack of nitrogen is the most common deficiency, especially on low natural areas and over-farmed fields. Symptoms are stunted growth and yellowing needles, although other nutritional deficiencies may produce similar effects.

Nitrogen fertilizers, such as urea, ammonium nitrate, and ammonium sulfate often produce spectacular improvements. Lush, dark-green needles are produced by most species during the first growing season after nitrogen is applied in April or May. Besides providing a dark-green color, nitrogen also stimulates tree growth. Excessive growth needs to be controlled by shearing. Needle color of pine is controlled primarily by genetics, so there will be little or no response to nitrogen.

On large areas, chemicals are sometimes broadcast by airplanes, helicopters, or tractor-drawn spreaders. Small areas can be treated by hand or by using light spreaders that can be carried--such as hand seeders and back-pack pumps.

5. Insects and diseases

On most Christmas tree operations, a light and spotty occurrence of insect and disease damage is common. There is no great cause for alarm as long as the incidence remains low. Environmental conditions that favor the development of certain pests can arise, however, resulting in economic losses. Prompt control is necessary if trees show undue loss of vigor, webs, spittle, deformed or dying shoots, unusual buildup of insect, visible fungal fruiting bodies, or discoloration and dropping of needles. Before control measures are used, consult your Extension agent or service forester. They can help you identify problems and recommend control measures.

Christmas tree areas are ideal breeding and feeding places for many destructive insects. No species or variety of evergreen is immune to insect attacks. Insect damage is likely to show up as one of three types--discoloration, defoliation, or general loss of vigor. Generally insecticides are most effective and least costly when used at the earliest sign of an infestation.

Recognizing and controlling diseases also can be vitally important in Christmas tree production. Some trees seem to be more susceptible to certain diseases than others. Such trees should be removed.

A common affliction of Douglas-fir is needle cast disease, Rhabdocline. This disease is caused by a fungus and can become a problem in dense pure stands of Douglas-fir. Reddish-brown spots develop in the spring on the previous year's needles, followed by premature dropping. Trees lightly infected in ordinary years lose their needles during years favorable to the spread of needle cast. Swiss needle cast disease causes similar needle loss.

Lodgepole and shore pine can become infected with western gall rust (Cronartium spp.). This appears as rounded, perennial galls on twigs, branches, and sometimes the main stem. Orange-colored spores occur on the galls in spring or early summer and spread directly to other pines. To prevent spreading, remove the galls before they become too numerous. Prune in the spring, before the spores form. Old gall-bearing trees in the area should be pruned or destroyed.

A similar but more deadly disease, white pine blister rust, attacks the 5-needle pines. Planting 5-needle pines in most areas of the Pacific Northwest is risky, because white pine blister rust is widely distributed.

Some relatively minor diseases may become serious if climatic factors are favorable to them. The following tables provide recommendations for insect and disease control.

Christmas Tree Disease Control

Disease	Disease description and damage	Host trees	Recommended treatment*
Douglas-fir needle cast (*Rhabdocline pseudotsugae*)	Mottled, red purple to brown spots on second-year needles, premature needle loss (this is the most important disease of Douglas-fir).	Douglas-fir	No effective control except removal of disease-susceptible trees which are severe spreaders during years when most other trees are not infected.
Swiss Needle Cast (*Phaeocryptopus gaumanni*)	Light green to yellow to brown needles are prematurely lost. Pin-point size black fruiting structures in rows on lower needle surface.	Douglas-fir	Use Daconil 2787 or Benlate (Washington and Oregon only) or Manzate 200 (Washington and Oregon only). If Benlate is used, alternate with another fungicide or tank mix with Manzate 200.
Needle rusts (*Uredinopsis pteridis* and others)	Orange or white spore pimples on undersides of needles in the summer—followed by winter browning and premature needle loss.	True firs	Difficult to control. These diseases infect alternate host plants, including bracken fern and huckleberry. Chemical control generally not effective.
White pine blister rust (*Cronartium ribicola*)	Slightly swollen elongated area on stems forming yellow-orange masses of spores in the spring. Portion of trees above disease gradually dies.	Pines (5-needle species)	Difficult to control on main stem, but infected branches can be trimmed off below the cankers.
Western gall rust (*Cronartium coleosporioides* and others)	Ball shaped galls on stems forming yellow-orange masses of spores in the spring.	Pines (lodgepole and shore)	Same as for white pine blister rust. Prune galls prior to spring spore release.
Red band fungus (*Dothistroma pini*)	Needles turn reddish-brown with distinct red bands—followed by shedding of the needles.	Pines (shore, lodgepole, bishop, Austrian)	Apply bordeaux 8-8-100* when new needles first appear, and thereafter every two weeks until needle elongation is complete.
Lophodermium needle cast (*Lophodermium spp.*)	Previous year's needles turn brown or red and drop during early spring. Small football-shaped black fungus fruiting bodies develop on infected needles.	Pines (mainly Scotch)	In infected plantations apply foliar sprays at 4-week intervals beginning in early June and ending in late September. Use Dithane M45 or Bravo according to label directions.

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* Refer to label instructions. Many labels do not mention Christmas trees specifically, but designations such as "ornamentals, conifers, trees, forest evergreens, firs, pines, spruce," etc., may be appropriate for a given situation. Label directions may not include the specific pests listed in this publication. If not, follow label directions for controlling similar pests which are listed on the label. Follow all label precautions.

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Christmas Tree Insect Control

Pest	Insect description and damage	Host trees	Recommended material*	Remarks
Adelgids:				
Cooley spruce gall adelgid *Adelges cooleyi*	Adults are tiny white woolly insects. White tufts appear on undersides of needles. Yellow blotches and twisting of needles result. Galls form on spruces.	Douglas-fir spruces.	Thiodan Sevin or Sevimol Metasystox-R ** diazinon**	Spray at or just prior to bud break or in the fall.
Balsam woolly adelgid *Adelges piceae*	Adults are tiny and soft-bodied. Swollen, stunted, and deformed twigs result.	True firs (especially grand, concolor, alpine, and silver).	Same as above. Orthene**	Spray in early spring (bud break). Thorough coverage is necessary. Difficult to control with anything other than high-pressure spray equipment.
Pine bark adelgid *Pineus strobi*	Woolly covered insects occurring on bark of limbs and trunk. Can severely distort new growth.	Pines	Same as above. Thiodan** Sevin not recommended in Idaho.	Spray at bud break, particularly bark of limbs and twigs.
True aphids:				
Conifer aphids *Cinera spp.* Spruce aphid Balsam twig aphid, and Woolly pine leaf aphid	Aphids of various sizes and shades of green, sometimes covered with powder or woolly material. Sometimes cause stunting. Honeydew secretions result.	Various conifers.	diazinon Orthene Metasystox-R Thiodan	Spray only when necessary.
Spittle-bug				
Pine spittle-bug *Aphrophora sp.*	Torpedo-shaped, vigorous jumpers, mottled wings. Immature feed under frothy spittle. Seriously affect growth in the leader and terminal twigs.	Pines	diazinon Metasystox-R Sevin or Sevimol Orthene**	Spray only when necessary. June application effective.
Moths:				
European pine shoot moth *Rhyacionia buoliana*	Larvae are brown caterpillars with black heads which burrow in buds and new shoots causing browning of some needles and shoot distortion.	Pines	Cygon Imidan Guthion (commercial applicators only)	Apply one of these materials at 2-week intervals starting approximately June 1, and ending in mid-July.
Silver-spotted halisidota *Halisidota argentata*	Clusters of caterpillars appear in webs on the branches, similar in appearance to tent caterpillars. Larvae feed on needles.	Douglas-fir, spruces, shore-pine	diazinon	Spray only when necessary and only on infested trees in fall, winter, or spring.
Beetles:				
Douglas-fir twig weevil *Cylindrocopturus furnissi*	Adults are small and covered with bronze or silvery scales. Larvae are tiny and white, and bore into pith of new growth causing leaders or branch tips to die.	Douglas-fir	Dursban. 4E	This material is registered in Washington and Oregon for use on Douglas-fir seedlings. Use 5⅓ oz. Dursban, 4E per gal. of water. Use one gal. of mix per 100 seedlings.

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Christmas Tree Insect Control (continued)

Pest	Insect description and damage	Host trees	Recommended material*	Remarks
Beetles: (Cont.)				
White pine weevil *Pissodes strobi*	Snouted weevil whose larvae mine and kill terminal leaders.	Pine, Spruce	Metasystox-R	Spray terminal shoots in early May and again in early June. Remove and destroy already infested shoots.
Flies:				
Douglas-fir needle midge *Contarinia spp.*	Adults are very small flies. Larvae feed within needles. Winter needle drop often occurs.	Douglas-fir	*Orthene, 75S (see remarks) (Thiodan is also registered for this use; however using it requires the use of fly-emergence cages to determine proper timing)	This use is registered in Washington and Oregon on Douglas-fir. Apply ¾ lb. of Orthene 75S per acre in not less than 2 gal. water per acre by aircraft or in 100 gal. water by ground equipement. Application should be made no closer than 2 weeks prior to bud break. If adelgids are also a problem use Thiodan rather than Orthene.
Mites:				
Eriophyid mites *Trisetacus spp.*	Microscopic torpedo-shaped mites which feed down in needle sheath causing twisting, yellowing, and death of needles.	Pines	Sevimol	Frequently ineffective for unknown reasons.
Spider mites *Tetranychidae*	Small, ranging in color from lemon-yellow and orange-red. Spin webbing especially on underside of needles where they feed and cause yellowing and drying of needles.	Most often encountered on Spruces	Use according to manufacturer's directions. Kelthane Vendex Pentac (spruce in covered or shaded areas)	Repeat applications may be necessary. Mites may be resistant to Kelthane in some areas.

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* Refer to label instructions. Many labels do not mention Christmas trees specifically, but designations such as "ornamentals, conifers, trees, forest evergreens, firs, pines, spruce," etc., may be appropriate for a given situation. Label directions may not include the specific pests listed in this publication. If not, follow label directions for controlling similar pests which are listed on the label. Follow all label precautions.

** Recommended as particularly effective in Idaho, but not in Oregon or Washington.

6. Weeds

Weeds are detrimental to Christmas trees in the following ways: they compete for moisture, nutrients, and light, and they provide a habitat for pests. Therefore, weed control is important in establishing and maintaining a stand of Christmas trees. Balancing the need for weed control is the need to prevent soil

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erosion. The grower should establish a program that eliminates competition during the growing season and provides adequate cover to hold the soil in the winter.

Depending on the type of operation, different species cause the most serious problems. In plantations, grassy and broadleaf weeds are prevalent, whereas in natural stands brush, undesirable trees, and bracken fern prevail. There are a number of chemicals available to control weeds. Most of them, however, will damage Christmas trees as well as the plants they are meant to control, if used improperly. It is best to consult your service forester or Extension agent for specific recommendations on the use of chemicals to insure effective control and safety. Also consult your state's weed control handbook or other Extension weed control publications for additional information.

7. Applying chemicals

New chemicals and improved methods of application are under constant test. Be alert to the growing opportunities for reducing costs of operation and improving tree quality by the proper and timely use of chemicals.

Spray applications can be made by using either aircraft or ground equipment. Aerial application is the best method where tree height does not permit use of boom-type ground sprayers. Boom sprayers mounted on tractors, four-wheel drive vehicles, etc., give good coverage but are limited to bare ground or small trees that will not be damaged by the equipment. Hand sprayers include mist blowers, compressed air sprayers, backpack pump sprayers, and sprinkling cans. They are used mostly for very small areas or for the spot spraying or individual trees.

Some commonly used herbicides (AAtrex, Kerb) are formulated as wettable powders. These materials do not dissolve in water or oil but form suspensions. Certain precautions should be followed to assure proper application of these suspension sprays.

Other herbicides frequently used in Christmas trees can be applied only as directed sprays or as preplant treatments. Paraquat 2,4-D, Dalapon, Amitrol, etc., are names of some of these chemicals.

Sometimes combinations of herbicides are used to improve weed control through increasing the percent of kill or including a greater variety of weed species. Consult the aforementioned publications as well as the herbicide labels for details of treatment application.

G. Harvesting and Marketing

The marketing effort that you make will help determine your degree of success. Harvesting and selling practices are closely related. Market preferences may change over periods of time, and harvesting practices will need to be fitted to the market situation.

About 80 percent of the trees marketed today range from 5½ to 7½ feet in height. Most larger trees are cut from natural stands or from older plantations where previous harvesting has resulted in wide spacing. Most smaller trees marketed are cut as thinnings.

Individual trees in the stand will vary in size, color, and shape. Every tree cut should be judged for quality and readiness for market. Hold a tree for another year or two if its quality and value can be substantially increased. Cutting will be speeded by pretagging those trees ready to harvest.

Choose quality trees with fresh, clean foliage and dense, uniform, well-shaped crowns. In the Pacific Northwest, Christmas trees with a cone shape are considered most desirable. A guiding principle for the taper of the tree is that the crown at the base should be from one-half to three-fourths as wide as the height of the tree--about a 50 to 75 percent taper.

Harvesting procedures depend on the method of sale. Offering standing trees is called "stumpage sales." In this case, the buyer does the harvesting. Letting a buyer select the trees introduces the rish of "high-grading." The buyer may choose to take only the very best quality trees. This can be controlled by doing your own tagging or by specifying a minimum number of trees that must be taken from each field or cutting block. Most growers, however, prefer to retain control of their stand by doing their own cutting.

Though some growers retail their trees at a lot or sell them "U-cut" at the tree farm, the majority sell to wholesalers or retailers with well-established outlets, thus avoiding the worries and risks of retail marketing.

When trees are sold to a retailer or wholesaler, the purchaser sets the shipping or delivery date. Cutting should be done as near the delivery or shipping date as possible so that trees reach the market in fresh condition.

1. Harvesting the trees

   The most common harvesting tool used in commercial operation is a light-weight chain saw.

   If the trees to be cut are not pretagged, the cutters must be able to select marketable trees. The cost of cutting and handling unsalable trees reduces the net profit on all trees. If unsalable trees are left uncut, some might be made into marketable trees through cultural practices.

   Each tree cut should have a short section of clean stem, called a "handle," between the butt end and the bottom branch whorl. A good rule is to leave 1 to 1½ inches for each foot of tree height, depending on the wishes of the buyer. Trees from natural stands are sometimes cut a few inches longer to allow for final trimming at the wholesaler's concentration yards. Those cut in plantations are usually cut to the exact desired handle length.

   After cutting, the trees are carried to the roadways and bunched for loading and delivery. Some buyers are willing to do their own loading and delivering. Others require the grower to do the loading, and perhaps the delivery to the place of business. In any event, the party responsible for doing each of these tasks should be spelled out clearly in the sale agreement.

   Growers in Mason and Kitsap counties in the southern Puget Sound area may be required to have their trees trucked to a concentration yard. Here, the trees are sorted, graded, tagged, baled, and butt-trimmed in preparation for shipment to customers. Growers near a good local market can make several cuttings and deliveries to a retail lot, thus insuring fresh trees to the customers.

   Harvested trees should not be baled until just before shipment. This prevents compressing and heating as as result of long storage in the bales. Cut trees should be assembled and stored under cool, moist shade and protected from wind and direst sun to retard moisture loss. Storage piles should be shallow to prevent compressed crowns, overheating, and to allow the absorption of rain.

2. Selling Christmas trees

   There are four possible ways to sell trees. You can sell to a wholesaler, sell to a retailer, sell at your own retail lot, or retail the trees on the stump on a "U-cut" basis.

   When selling trees to a wholesaler, you can sell trees at any of the following points:

   a. Standing in the field or forest (stumpage sales)
   b. Piled by the roadside or loaded on trucks at the Christmas tree farm
   c. Loaded on trucks at the roadside
   d. Delivered to a rail head
   e. Loaded on rail cars
   f. Delivered to a concentration or processing yard
   g. Delivered to a retailer who is a customer of the wholesaler

   When selling trees to a retailer, you can sell trees at any of the following points:

   a. Standing in the field or forest (stumpage sales)
   b. Piled by the roadside
   c. Loaded on trucks at the roadside
   d. Delivered to a retailer's storage area or a retail lot

3. Consignment

   Consignment is a poor selling method because the grower is paid only if the buyer is able to sell the trees. It is a risky procedure, because the grower has no guarantee that the buyer will sell the trees or report truthfully the number of trees actually sold.

4. Selling to a wholesaler

   Growers of large numbers of trees probably will find wholesaling the best method of sale. You will want to do business with established, financially responsible firms only. Christmas tree selling is a short-term, fast-moving operation that calls for cash payments or contracts that are as good as cash.

Having a sales contract is strongly recommended. This protects both parties by spelling out what each agrees to in the transaction, and avoids later misunderstandings. (See Sample Sales Contract, page 32.)

Ask the advice of experienced local authorities and be sure the contract covers every important consideration for both parties. The contract must be in proper legal form, so check it with a qualified attorney when you have decided what to include. A common requirement of Christmas tree sales contracts calls for a 50 percent payment at the time of contract and the remainder by cash, money order, or certified check before the trees are loaded for shipment.

Trees for sale need to be advertised early so that prospective buyers will be informed and have the opportunity to inspect your crop. In soliciting bids, the quantity, quality, and species for trees for sale should be indicated. When and where the trees can be seen should also be included. The seller should designate which trees are for sale by tying brightly colored strips of plastic to the leaders. This enables the buyer to judge the offered trees. It also facilitates tree cutting.

Keeping up on tree values is a must in effective selling. Prices vary widely depending on location, demand, species, and quality. The price of cut trees stockpiled or loaded on trucks at the farm usually varies from 30 to 50 percent of the consumer price. If the buyer buys stumpage and does the harvesting, the price is usually 25¢ or 50¢ less per tree.

Following are some ranges of returns at different marketing levels based on a percentage of the retail price.

Marketing level	Percent
Producer	30 to 50
Wholesaler	10 to 20
Retailer	40 to 50

AgIII-XVI-32

Sample Christmas Tree Sales Contract Between Grower and Purchaser

Christmas tree seller ______________________________
(Name)

____
(Address)

hereby agrees to the following conditions:

1. Supply Christmas trees, as described below, to the purchaser:

Species	Height	*Grade	**Type of Shearing	No. of (Trees) (lin. ft.)	Price per (Tree) (lin. ft.)	Total Price
			TOTAL			

* Grade examples include "Field-run as tagged and "U.S. #2 & Better."
** Types of Shearing examples include "Plantation Sheared," & "Light Sheared."

2. To *(sell on the stump)* *(stockpile on accessible roadway)* *(load on truck)* *(load on rail car)* *(deliver trees to* ______________________________*)* at date and place notified by purchaser.

3. In event that contracted trees cannot be cut or delivered within ______ days of date and time notified by the purchaser, because of weather, fire, theft, or other conditions beyond the seller's control; the seller shall return the purchaser's advance deposit within 10 days of notification date.

Christmas tree buyer, ______________________________
(Name)

____
(Address)

hereby agres to the following conditions:

1. Pay the Seller an advance deposit of $__________ not later than ______________ (Date), this amount to be applied on the total purchase price of the trees.

2. Pay the Seller the balance payment due, based on actual tree tally, with certified check, money order, or cash not later than (______________ (Date)) (before any of the trees leave the point of delivery).

3. Notify the seller ______ days prior to the desired *(harvesting)* *(stockpiling)* *(loading)* *(delivery)* dates, which in any event will not be later than ______________ (Date)

4. Forfeit $__________ of the advance deposit in event of failure to comply with paragraphs two and three, above.

Buyer's Signature ______________________________

DATE
Month __________ Day ______ Year __________

Seller's Signature ______________________________

DATE
Month __________ Day ______ Year __________

Of vital importance is getting the trees to the market at the right time. The cutting and delivery arrangements should be agreed on when the contract is signed. Contract arrangements with the buyers should be completed by October 1.

The grower should have some knowledge of comsumer demands at various retail outlets. Growers can tailor production to demands and at the same time increase buyer interest in the crop.

5. Selling to a retailer

Procedures are similar to that of selling to a wholesaler, but usually smaller quantities of trees are involved. Somewhat higher prices often are charged to retailers than to wholesalers in order to protect the wholesaler's profit margin and compensate for higher costs of handling small quantities of trees. The most common practice is selling stockpiled or truck-loaded trees at the farm. However, some retailers prefer to cut their own trees or have them delivered directly to their retail lots or stockpiled in town.

6. Selling at your own retail lot

Small growers who can retail their own trees may gain by doing so, since retail prices of Christmas trees are frequently double those of wholesale prices. Consider possible problems of direct competition with retail lot operators or large chain stores and other business establishments that use Christmas trees only as lead items for the Christmas rush.

Growers who retail their own trees can:

a. Learn first-hand what Christmas trees the public wants and how well their trees measure up to demands.

b. Keep a fresh supply of trees on hand by cutting frequently.

c. Arrange and display trees to best advantage.

d. Capitalize on specialities of the season--wreaths, cones, greens, and special orders for flocking.

Successful retailing of Christmas trees depends on many things. Nearness to larger population centers, good advertising in local newspapers and on radio and television, good lot location, adequate parking space for customers, enticing displays, and prompt, courteous attention to customers are a few of the keys to success in retailing Christmas trees.

Along with the advantages of retailing are some business problems. Establishing a retail yard involves costs for licenses, space rental, light, water, business fixtures, security, and advertising. Enough trees must be sold to pay for these costs.

Good advertising, merchandising, and sales techniques will help. The public will pay more for the best, so grade the trees and price them according to quality. Show customers the different grades. Display trees effectively and separate by species, size, and quality. Use good labels that advertise your quality trees at competitive prices. Try to have ample space for displaying trees and parking cars. A good location for the Christmas tree lot is important. It is sometimes hard to find and it may be costly for such a short time as the 3-week period when most trees are sold.

When selling Christmas trees retail, remember to:

a. Concentrate on high-quality trees. Buyers will take them, like them, and pay more for them.

b. Pre-price the trees and display then in individual stands.

c. Sell on a cash basis.

d. Hold trees for customers only when a substantial deposit has been made.

e. Increase sales by advertising.

f. Cut and deliver at frequent intervals to insure freshness and to avoid large unsold inventories.

7. Selling U-cuts

Many people like to choose and cut their own trees at the Christmas tree farm, rather than buy them from a lot in town. Retailing by the "U-cut" method at Christmas tree farm will eliminate rental and other costs of the city lot, but will involve some other considerations.

"U-cut" sales must have a variety of species. They must be reasonably accessible, and adequate roads or trails must be built throughout the cutting areas. There must be restrooms and space for parking cars. It is necessary to furnish the hand saws and maintain the premises in a safe condition for the public. Adequate public liability insurance is an essential precaution in such an operation.

8. Retail specialities

Along with the Christmas trees, specialty items connected with the Christmas season can be made, displayed, and sold at the lot. These may offer additional profit opprotunities.

The most popular item is fragrant bunches of cedar, pine, and noble fir boughs. Wreaths, door swags, tree cones, holly boughs, and mistletoe are additional possibilities. Some retailers keep a supply of Christmas tree stands on hand for sale. Water stands are a particularly good item because they keep a tree fresh and natural-appearing during its display season. Fresh, moist needles are very flame resistant, as well as attractive.

Some people like their trees flocked with artificial snow. Flocking usually doubles the price of a green tree. Flocked trees must be stored and displayed where they can be protected from wind and rain.

Some people are concerned about the fire hazzard of a Christmas tree. Assure then that a fresh tree is the most fireproof tree. Mounting the tree in a water stand and keeping it away from heat outlets will help maintain freshness for several weeks.

9. Christmas tree grades

United States standards for grade of Christmas trees were established in 1957, and revised in 1973 by the Agricultural Marketing Service, USDA. These are voluntary standards, but they establish a sound and practical basis for determining quality and price. The grades can be applied to either sheared or unsheared trees of any coniferous species normally marketed as Christmas trees.

Three grades are recognized. These are U.S. Premium, U.S. No. 1, and U.S. No. 2. Grades are based on density, taper, balance, foliage, and deformities of the tree. The table on page 36 shows requirements for each grade.

Christmas Tree Grades

Factor	U.S. Premium	U.S. No. 1	U.S. No. 2
Density	Not less than medium	Not less than medium	Light or better
Taper	Normal—40 to 90%	Normal—40 to 90%	May be les than 40% or more than 90%
Foliage	Fresh, clean, and healthy	Fresh, clean, and healthy	Fresh, fairly clean, and healthy
Shape	Well-shaped crown. Handle not less than 6" or more than 1½" per foot of tree height.	Well-shaped crown. Handle not less than 6" or more than 1½" per foot of tree height.	Well-shaped crown. Handle not less than 6" or more than 1½" per foot of tree height.

Height of a tree is defined in terms of foot or half-foot steps, and is measured from the base of the handle to a point on the leader not more than 4 feet above the apex of the cone of the taper.

Taper of a tree is defined as the width of a tree expressed as a percentage of its height.

10. Laws and requirements

Most states regulate the harvesting of forest products and have certain requirements for out-of-state shipments. The federal government or the states may impose quarantines as protective measures. Licenses are required for hauling between states as well as "for hire" hauling within states. The following is a summary of regulations that affect the Christmas tree business in Washington, Oregon and Idaho.

Legal Requirements for Harvesting, Selling, and Transporting Christmas Trees in Oregon, Washington, and Idaho

Requirement	When required	Where obtained
1. Oregon		
Notification of Operation Oregon Forest Practices Act	All commercial cutting on wildlands not managed solely for the production of Christmas trees	State Forestry Department
Bill of sale	Transporting more than five trees	From seller
P.U.C. permit	Over 6,000 pounds gross wt.	P.U.C. offices
Report of Christmas trees harvested	Cutting from all ad valorem-taxed private lands	County tax assessor
Retail licence or permit	Most cities	City hall
2. Washington		
Specialized forest products permit	Cutting more than five trees	County sheriff's offices or Department of Natural Resources offices.
Forest excise tax form	Harvesting from natural (not plantation) Christmas tree lands	State Department of Revenue
Yield tax permit and yield report	Cutting from 1931 Reforestation Act classified lands	County assessor
Either a sales invoice, bill of lading "Authorization" for or true copy of the specialized forest products permit	Transporting more than five trees	From seller for invoice. From carrier for bill of lading. From county sheriff or Department of Natural Resources for harvesting permit

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Requirement	When required	Where obtained
Utilities and Transportation Commision permit	Contract haulers only	U.T.C. offices
Registration for Washington state sales tax	All wholesalers and retailers	State Dept. of Revenue
Retail license or permit	Most cities	City hall
3. Idaho		
Bill of sale or proof of ownership	Transporting more than two trees outside incorporated cities	From seller
Seller's permit number for Idaho state sales tax	For all retail sales	Idaho State Tax Commission
Retail license or permit	Most cities	City hall

Trees entering California pass through inspection that may request bills of sale certifying ownership of trees. Insect and disease pest inspections may be made.

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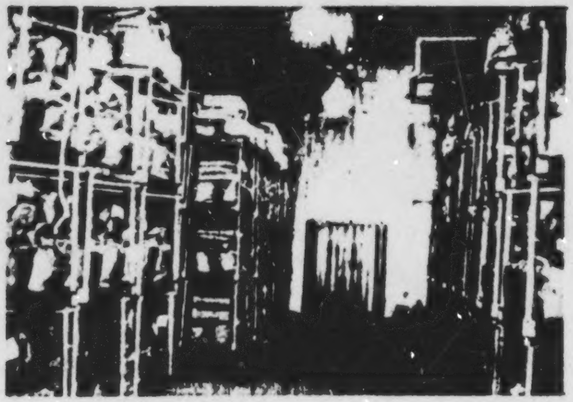
Continued identification through lifting operations is important. No one likes mixed lots or gambling at outplanting time.

Which level of assurance?

The certification program provides correct source identification by "levels of assurance." Six levels are designated, with the first three for special, genetically improved or selected seed. Most Northwest seedlings are sold by the following assurance levels:

- *Source Identification*—Each seed or seedling container is sealed and labeled by the certifying agency. The label is yellow, serially numbered, and clearly marked as to which certification class or subclass the material represents. Two source-iden classes are recognized:
  - *Sub-class A*—Seedlings grown from seed that was collected under personally supervised conditions. This is the best choice for correct source identification.
  - *Sub-class B*—Seedlings grown from seed collected under procedurally supervised conditions. This is a satisfactory class of source identification.
- *Audit*—Seedlings grown from seed for which the procedures, inventory, and sales records of the seed producer have been audited and found satisfactory. This means that the source identity of the seed corresponds with the inventory records when sold.



Bags of source-identified seedlings awaiting outplanting. Certification assures you that what the label specifies is what you get.

Prepared by Scott Wolff, seed certification assistant, Oregon State University Extension Service. Photos courtesy U.S. Forest Service, Bend Nursery

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Certified Tree Seeds and Seedlings

Extension Circular 1050
January 1981

Oregon State University
Extension Service

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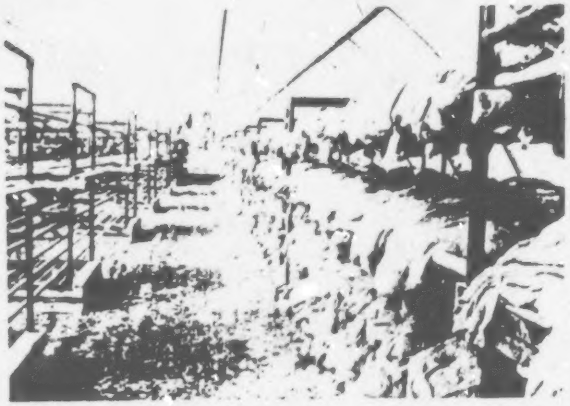
Why match the seedling source to the site?

Forest research and observations confirm that naturally established trees are, by their very existence in the area, adapted to their environment. Their genotypes have favorable survival and growth characteristics for that environment. The local trees leave the most viable offspring; thus, adapted characteristics are perpetuated.

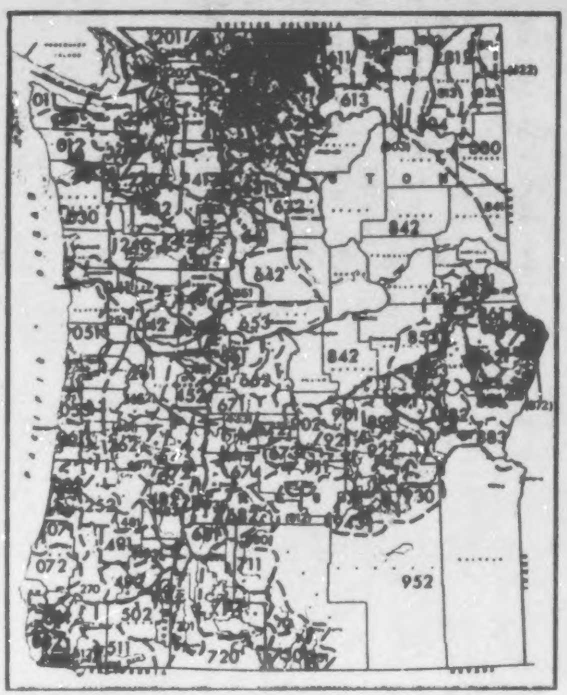
The seed source with the best general adaptations to a site is from the immediate vicinity of the area to be reforested. This "immediate vicinity" depends on the geographic location. Seed sources north or south of the planting area are sometimes considered "local," but it is still a risky business to use seed collected far from the intended growing location. Local seed source usually implies same drainage, same elevation, and in some cases the same aspect—sunny or shaded, windy or sheltered, level or steep slope. The more environmental conditions vary with distance, elevation, and aspect, the more restricted the meaning of local source.

Using seed or seedlings from a non-local source can lead to initial failure of seedlings to survive, plantation loss later in the rotation, or establishment of a less valuable crop. Off-site seedling stock may introduce genetically undesirable material through pollination of native trees by the off-site trees and establishment of reproduction from off-site parents. Forest land managers should insist on knowing the origin or source of the seed or seedlings they use in silvicultural operations.



Cones in storage should be labelled carefully. This is the first step in the identification chain for certified seedlings.

Tree Seed Zone Map



Western Forest Tree Seed Council

Why are seedlings certified?

Certified seedlings are grown from seed that has been harvested, extracted, stored, and sold in compliance with the Official Certification Standards of the legally appointed state certification agencies. In Oregon this is the Oregon State University Seed Certification Service. Production of source-identified class tree seedlings follows procedures carefully developed to assure that seed is of known geographic origin and elevation.

Certified seed is identified for origin by the Tree Seed Zone map illustrated. The zone boundaries separate areas of different physiographic and climatic conditions. Within each zone elevational bands of 500 feet are designated.

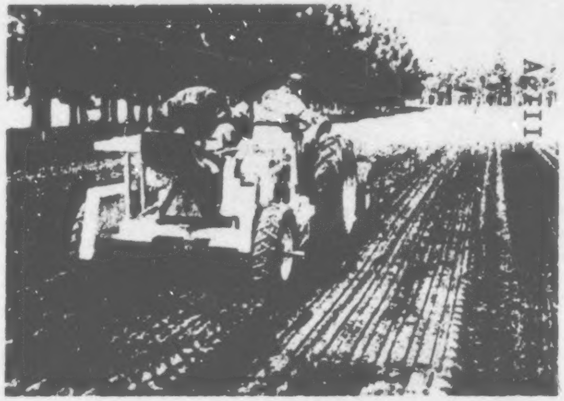
Why certify seedlings?

Forest tree seedling certification maintains the identity of the tree seed from the cone on the tree to the plant in the ground. The certification agency lows these steps:

- With application for certification of seedlings, the agency will receive an identification of the lots of seed and the nursery location.
- Checks seed source for proper identification.
- Checks stratification procedures and maintenance of proper seed identification.
- Checks sowing procedures. Beds must be clearly marked and separated, with 3 feet between seed lots.
- Checks the nursery record system to assure an "unbroken chain" of identification. After seedlings are up, a "green tree count" or rough germination check will be performed.
- When the lot of trees is lifted, varifies that seals are affixed to the packages of trees for identification of the proper certification class.

How can you recognize certified seedlings?

All certified seedlings from Oregon or Washington, or those seedlings grown out of Oregon and Washington under certification standards, must be officially tagged and sealed with an official label stating in which class these seedlings are certified. All documentation should reflect this same certification identification.



Precision seeding entails many essentials, but none is more important than proper identification of each lot.

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Extension Circular 1099
May 1982

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The Woodland Workbook

Multiple Use

Christmas Trees in the Small Woodland

Christmas tree production has been very attractive in recent years. The Oregon State University Extension Service estimates that the value of the Christmas tree crop in Oregon has risen from $8 million in 1977 to more than $24 million in 1981. These figures represent a lot of activity, and many people have expressed an interest in taking part.

The attractiveness of Christmas tree growing to woodland owners lies in the short turnover of the crop as well as in its potential for profit. This circular presents some pros and cons of growing Christmas trees and outlines aspects of Christmas tree culture for the prospective grower.

Many people have the impression that, to grow Christmas trees, all one has to do is place seedlings in the ground and harvest them a few years later—and that this can be done on land not suited for growing timber. Twenty years ago, this was nearly the case. Growth was controlled by planting trees on poor sites.

However, grower sophistication and competition have increased; and Christmas tree production has been shifted to the best sites for rapid growth. Horticultural techniques have been adapted for use in controlling growth and improving quality. Producing and managing Christmas trees requires a different set of skills and information from those used in growing timber.

An important factor to consider is that the Christmas tree industry is cyclic; successful growers have to adapt to the ups and downs of the market. The Northwest, along with the rest of the country, has a huge inventory of seedlings in the ground. Industry sources forecast a glut of harvestable Christmas trees in the near future. The Northwest, in particular, is sensitive to national overproduction because this region depends heavily on exports to distant markets. The traditional market has been California, but in response to the last tree surplus, markets have opened up in Texas, the South, and the Northeast. However, it will be more difficult to compete in these areas as production overtakes demand throughout the nation. The anticipated downturn will hit small and new growers the hardest.

Site and species selection

Most production of Christmas trees in Oregon is in the foothills of the Coast Range and the Cascades, on the outer edges of the Willamette Valley. The soils in these areas are moderately fertile, have moderate to high water-holding capacity, and are well drained. Often the land has been used for other crops in the past.

Growers should avoid certain conditions:

- Strong south slopes and areas that have shallow soil dry out quickly in the summer. Under these conditions, trees are difficult to establish. Survivors will grow slowly and will have poor quality growth.
- Wet conditions reduce seedling survival and distort growth. Weeds adaped to poorly drained soils will grow well and provide strong competition for tree seedlings.
- Growers should also avoid areas that frequently have late spring frosts. The tender growth of conifers is cold-sensitive, and frost damage to the shoots will delay development of marketable trees.

Douglas-fir is the leading Christmas tree species grown in Oregon, accounting for about 75 percent of production. It can be grown under a variety of moderate conditions to produce high quality Christmas trees. Typically, growers can harvest Douglas-fir Christmas trees in 6 to 9 years.

Many growers are using seedlings from areas identified as producing superior Christmas trees. Medium-elevation strains from the Willamette basin are suitable, as are the

Oregon State University Extension Service

Vancouver Island (Duncan) and Shelton (Lake Cushman) sources. These strains tend to be vigorous, and they have upright branching habits and good needle color. A drawback of these coastal Douglas-fir strains is their sensitivity to stress after harvest, which causes rapid defoliation.

A factor often overlooked in seedling selection is date of bud-burst. Early bud-bursting strains of Douglas-fir are more vulnerable to damage from Douglas-fir needle midge, frost, and some fungal infections. Growers can partially overcome these problems by selecting from the same elevation or up to 500 feet above the plantation. In general, too, sources within 50 miles to the south or 150 miles to the north are acceptable.

A refinement in seed selection is to select individual trees that produce desirable seedlings. The Northwest Christmas Tree Association as well as some growers have advanced to this stage. The association has propagated a number of Douglas-fir trees in a seed orchard that will produce generally superior seedlings.

The association is also supporting work at Oregon State University to select superior Douglas-fir and propagate them from cuttings. The commercial development of clonal stock represents the ultimate in genetic quality of Christmas trees.

The true firs, especially noble fir, are regarded as top-quality Christmas trees. Unfortunately, the higher price that they bring often does not make up for their longer rotation period, 8 to 14 years. The true firs are difficult to grow, as they require cooler, moister summer conditions than do Douglas-fir or the pines. The best sites are usually at or above 1000-foot elevation on gentle, well-drained, north or east slopes. Noble fir can be grown at lower elevations, but the trees are subject to many problems.

Two superior seed sources have been identified for noble fir. These are the upper Siletz River drainage in the Coast Range of Oregon, and the upper Kalama River drainage in southwestern Washington. Seeds from the Cascades east of Molalla are also being used successfully.

Grand fir from northern Idaho and southeastern Washington have been generally regarded as high quality trees. Grand fir is the easiest to grow of the true firs, but it accounts for only a small percentage of production.

Scotch pine is widely used for Christmas trees in the United States, accounting for about 35 percent of national production. Seedlings from sources in southern France and Spain are preferred for planting in the Northwest. Fewer and fewer Scotch pine are being grown in Oregon, however, because of outbreaks of *Lophodermium* needle cast and the European pine shoot moth. The moth damages trees and is a quarantined insect in California.

For these reasons, Scotch pine is relatively unattractive to growers and buyers. It is regarded as a species to grow on poor sites. It is true that the species will tolerate more extremes, but the quality of growth will not be as good as that on better sites.

Ground preparation and planting

In order to enhance tree survival and growth, growers must stifle weed competition. In most cases, this means tillage to eliminate the majority of the weeds. Tillage is also important to loosen the planting bed to permit vigorous root growth. However, some growers have adopted no-till methods of field preparation. Untilled fields are difficult to machine-plant, but you can plant earlier and reduce erosion.

A number of herbicides are registered for use in Christmas tree plantations, and it is important to select an appropriate chemical for the particular problem. If you are dealing with site preparation, new or established plantations, or if you must control grasses, broad-leaved weeds, or brush, certain herbicides will work best.

Planting quality seedlings in the well-prepared field is the critical step in establishing a Christmas tree plantation. Most seedlings are grown by commercial nurseries and planted as 2-0 stock. Some growers are beginning to use 2-1 stock (that is, 2-year-old trees transplanted and grown in beds for another year).

These trees are bigger and better developed than 2-0; consequently, survival is better, and faster growth will shorten rotation. The decision to use 2-1 stock rests on its availability, adaptability to planting machines, and costs. You can easily recover the cost of 2-1 seedlings, however, through the shortened rotation.

Investing in high quality seedlings is important, and proper handling of those seedlings is necessary to ensure their survival. Because most seedlings are dug and shipped bare-root (container-grown seedlings account for only a small percentage of planting), they are very sensitive to drying. You should time the shipment of seedlings to coincide with harvest, so that you can plant them immediately.

If planting will be delayed, you must find proper storage facilites. Ideally, you should keep bundles of seedlings in refrigerated (35°F) storage. Even under these conditions, you must moisten stock frequently, If refrigerated space is unavailable, you can heel-in the seedlings in moist, well-drained beds.

Nearly all Christmas tree seedlings are planted in the spring, as soon as the field is dry enough to enter. That date wil be earlier for hand planting than for machine planting. Large, clean fields are usually planted mechanically, but untilled or small areas are usually planted by hand. Caution is required to ensure proper placement of the roots in the soil. Turned up roots ("J-roots") or excessive compaction of the soil around the roots can hinder root growth and stunt or kill the seedling.

Even for the few hours the seedlings will be exposed in the field, you must take precautions to protect them. Ice chests, space blankets, or other insulating material are satisfactory. Do not use materials like canvas tarps; the seedlings will quickly overheat.

Tree spacing depends on the market you plan to develop. Spacing of 5½ x 5½ feet to 6 x 6 feet is the most common arrangement for the typical 6-foot tree. Closer spacing is appropriate for small trees and a quicker harvest. Some growers are experimenting with 3-foot spacing, harvesting every other tree at tabletop size, then growing the remaining trees to standard size.

Woodland owners may harvest a crop of standard trees and leave enough trees to stock the land for timber. In laying out the fields, allow enough space for an adequate network of roads. Roads make culture and harvest easier, and they serve as firebreaks. Spacing averages about 400 feet.

Culture

After planting, the primary cultural tasks are to control weeds, replace dead and injured trees, and prune multiple leaders in the seedlings. During the first 2 years in the field, the seedlings should become well established, developing size and vigor to tolerate shearing.

Douglas-fir is usually ready to basal prune by the third growing season. Basal pruning removes the lower branches up to the first whorl to form a handle. This aids in cutting and handling the tree at harvest and supporting the tree in the home. Excessive removal of foliage to form the handle will shock the tree and slow growth unnecessarily. Do not basal prune any more than one-third of the foliage.

Basal pruning of noble fir has the additional function of growth control. The desired length of noble fir leaders is 12 to 16 inches. Trees with long leaders are lower quality, because of their light density. Various techniques to limit leader growth are used. Basal pruning of noble fir is usually performed when leaders growth reaches the ideal range of 12 to 16 inches. By removing the lower branches to form the handle, you can reduce growth the following year. You can control leader extension in future years by pruning or scarring.

When you control leader length, you must also side shear to keep the tree in balance. Shearing begins the third or fourth summer after planting and is continued each year with harvest. It is the major cultural activity of the Christmas tree grower, and is usually done in July and August. Knives are the most common shearing tool, but mechanical shearing techniques are being developed. By modifying tree growth and making a denser, more uniform plant, you can produce more saleable trees than would otherwise be possible.

Pest control

Pest damage is usually light but frequent in Christmas tree plantations. Simple cultural precautions often prevent damage. For example, rank weeds may encourage deer, provide habitat for mice and rabbits, or be alternate hosts for disease organisms. Bracken fern is the alternate host for a rust fungus that attacks true firs. The disease must alternately infect firs and ferns to complete its life cycle—thus the need for adequate weed control. In addition, remove at once trees that are attacked by diseases if effective chemical controls are unavailable.

Several pests are particularly common and are worth mentioning here. The Douglas-fir needle midge hatches at average bud-burst in the spring to lay eggs on tender shoots. Subsequent larval development injures the needles. Adequate chemical control is available, but you can thwart the insects' cycle by planting late bud-bursting strains of Douglas-fir. This strategy bypasses the time when the midges are most active. In addition, it helps to avoid frost damage.

Swiss needle cast is a fungal disease of Douglas-fir that is now locally severe in the Northwest. Small black spots develop on the underside of the needles in the spring. As the result of tissue damage, the needles then fall off the following summer (1 year later). Heavy infections of this disease make the trees unsaleable. Chemical control has been developed and approved for Swiss needle cast.

Another fungal disease of Douglas-fir is *Rhabdocline*. Reddish-brown spots develop in the spring on the previous year's needles, which fall off prematurely. There is no effective chemical control available.

Deer damage to succulent leaders of Douglas-fir is often a problem. Some repellents are available, but repeated application is necessary.

In summary, some losses to pests can be expected to occur in Christmas tree plantations. To date, potentially devastating pests have been controlled, often through simple cultural or genetic practices, such as planting seedlings from the correct seed source.

Harvesting and marketing

Start locating buyers for your trees before they are ready to harvest. Buyers may have suggestions on how to culture the trees that will make the trees more marketable, and it is helpful to establish a relationship with the individuals you are dealing with.

The greater the effort you put into marketing trees, the greater the success you can achieve. By learning what the market trends are, you can anticipate future customer preferences. For instance, a trend toward shorter, more lightly sheared trees is in evidence. Such trees fit in smaller homes and are lighter to ship.

Growers usually sell trees to wholesalers. Arrange for enough time for buyer and seller to inspect the trees and agree to terms so that neither party is rushed into a deal. The terms of the sale should determine how many or which trees will be cut in the block; the price; and who will cut, yard, load, coordinate truck schedules, and pay for shipping. Once this is decided, harvest will proceed according to the agreed shipping dates.

Traditionally, Christmas tree harvest has been labor-intensive. Trees are felled by chain saws, carried to the nearest road, loaded on a wagon, and hauled to the concentration yard where they are sorted, graded, baled, tagged, and loaded on a truck for shipment.

This scenario is changing as growers develop new machines to increase efficiency. Implements are being introduced to cut trees easier and faster. Several growers have built hydraulic devices to compact many trees into a large bale that can be handled by helicopters and forklifts for easier yarding and truck loading. Eventually, trees may be harvested almost without being touched by human hands.

Christmas tree growing can be a productive addition to a woodland operation. However, increasing competition requires that growers dedicate themselves to intensive care of the plantation and pay close attention to marketing in order to profit from the experience.

See your county Extension forestry agent for publications covering other aspects of Christmas tree production.

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This publication *was prepared by W. M. Proebsting, Extension Christmas tree specialist. It is one of a series of publications being developed as an Extension* Woodland Workbook. *Your county Extension forestry agent has additional information.*

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Developing High Quality True Fir Christmas Trees

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CONTENTS

Page
A. INTRODUCTION 3
B. RECOMMENDED SPECIES AND STRAINS 4
  1. Noble and Shasta red fir 4
  2. Grand fir 5
  3. Exotic species 6
C. MATCHING SPECIES TO SITE 7
D. PLANTING 7
E. CONTROL OF COMPETING VEGETATION 8
F. PROTECTION 9
  1. Insects 9
  2. Diseases 10
  3. Excessive Soil Moisture or Drought 10
  4. Animals 11
  5. Fires 11
  6. Trespass 11
G. SHAPING THE TREES 11
  1. Overall Objectives 11
  2. Correcting Multiple Leaders 12
  3. Basal Pruning 12
  4. Replacing Lost Leaders 14
  5. Leader Pruning and Side Shearing 15
    a. Definition 15
    b. Noble fir and Shasta red fir Techniques 16
    c. Conclusions from a Noble fir Shearing Study 17
    d. Grand fir Techniques 18
    e. Conclusion from a Grand fir Shearing Study 19
H. STUMP CULTURE 19
I. FERTILIZING 20
J. NUMBER OF YEARS REQUIRED TO GROW A MERCHANTABLE TREE 20
K. SEASONAL CULTURAL INSTRUCTIONS 21
L. CONCLUSIONS 21
M. PROTECTION 22
N. HARVESTING AND MARKETING 22
O. SOURCES OF ASSISTANCE AND INFORMATION 22

DEVELOPING HIGH QUALITY TRUE FIR CHRISTMAS TREES

A. INTRODUCTION

True firs are defined as all species of the genus *Abies*. About 50 true fir species are widely scattered throughout North America, Central America, Europe, Asia and North Africa. Six species of true firs are natives of the Northwest. As shown in Table I, the three most popular native species are noble fir (*Abies procera*), Shasta red fir (*Abies magnifica* var. *shastensis*), and grand fir (*Abies grandis*). Table II shows that the popularity of the true firs is increasing. They accounted for about 9% of Oregon and Washington Christmas tree production in 1969. Ten years later, true fir production has increased to nearly 22% and further increase is expected to continue into the 1980's though at a slower rate.

Table 1. True Fir Christmas Tree Production in Oregon and Washington — 1979*

	Number of Trees Harvested			
Species	**Oregon**	**Washington**	**Both States**	**Percent**
Noble	435,000	250,000	685,000	68.5
Grand	80,000	70,000	150,000	15.0
Shasta red	50,000	60,000	110,000	11.0
Concolor	20,000**	3,000	23,000	2.3
Silver	2,000	15,000***	17,000	1.7
Fraser	1,000	6,000	7,000	0.7
Alpine	1,000	5,000	6,000	0.6
Others	1,000	1,000	2,000	0.2
Totals	590,000	410,000	1,000,000	100.0

* Composite of estimates by several leading PNW producers

** Principally harvested from Eastside natural stands

*** Harvested from Westside high elevation natural stands

Table 2. Christmas Tree Production in Oregon and Washington — 1969 and 1979 Comparisons

		Number of Trees Harvested*			
Species	**Year**	**Oregon**	**Washington**	**Total**	**Percent**
Douglas-fir	1969	525,000	1,890,000	2,415,000	83
	1979	2,000,000	1,500,000	3,500,000	75
Noble, Shasta red, Silver, Alpine and Fraser	1969	85,000	55,000	140,000	5
	1979	490,000	337,000	827,000	17
Grand and Concolor	1969	95,000	35,000	130,000	4
	1979	100,000	73,000	173,000	5
Scotch pine	1969	45,000	120,000	165,000	6
	1979	40,000	70,000	110,000	2
All others	1969	40,000	30,000	70,000	2
	1979	40,000	20,000	60,000	1
Totals	1969	790,000	2,130,000	2,920,000	100
	1979	2,670,000	2,000,000	4,670,000	100

*1969 Estimates obtained from *Natural Products Harvesting Report for Oregon and Washington*, U.S. Forest Service, Portland, Oregon.

1979 Composite — estimates by leading producer and wholesaler members of the Northwest Christmas Tree Association.

What are the reasons for this growing popularity of the true firs? Firstly, they are widely acclaimed as the most beautiful of all Christmas trees. Needles are dense, stiff, thick and dark green in color. The sturdy branches, symmetrically arranged in spaced whorls, are well adapted to support and display heavy pendulous ornaments. Secondly, an important asset of noble fir, and to a lesser degree for the Shasta red fir, is good needle and moisture retention during the shipment, storage and display. These characteristics have helped open new and expanding markets outside the Pacific Northwest, particularly in the southern tier of states from California to Florida.

Relatively high selling prices have boosted the number of true fir plantings. It is often said that noble firs (which generally are lumped with Shasta red firs in the trade) are the "Cadillac" of Christmas trees. This reputation is reflected in its selling price which averages about 50% more than Douglas-fir and pine and about 25% more than grand fir. New seed source information and better cultural practices have provided another stimulant to Northwest true fir plantings. This will be discussed later in more depth.

A few words of caution are directed to those who are thinking about establishing true fir plantations. True firs are the most difficult species to develop into salable quality trees due to characteristically slow growth and being very particular as to site. An estimated 60% of all true fir plantations fail to develop properly and turn a profit for their managers. Frequent problems include improper seed sources, poor matching of species to site, and unskilled cultural practices, especially shearing. A major objective of this publication is to help you avoid these pitfalls.

Less than 20% of the true firs harvested in Oregon and Washington in 1978 were grown in natural stands while the majority were plantation grown. Ten years earlier, these percentages were almost reversed, with only about 30% produced in plantations. A continued decline in production from natural stands appears inevitable due to growing consumer preference for the narrower, more dense, and symmetrically shaped plantation tree.

Growing high quality Christmas trees of any species requires a heavy investment of time, money and knowledge. This applies particularly to true fir species which are more difficult to develop than any other species. Relatively few growers have developed profitable true fir plantations. Most of the successful growers have paid strict attention to selecting good growing sites, planting seed from a suitable source, and using skilled cultural practices. This bulletin will describe conditions and practices that these successful growers have used or developed.

B. RECOMMENDED SPECIES AND STRAINS

The best prospects for Christmas tree plantations in Oregon and Washington are three of the native species: noble fir (*Abies procera*), Shasta red fir (*Abies magnifica* var. *shastensis*), and grand fir (*Abies grandis*).

Some concolor fir (*Abies concolor*), especially of Southern Rocky Mountain origin, have been developed into attractive Christmas trees in southern Oregon. However, in most areas they frequently suffer from terminal dieback, poor needle retention, frost damage, and slow juvenile growth. The use of silver fir (*Abies amabilis*) and alpine fir (*Abies lasiocarpa*) has shown little potential on lowland plantations and such use is not apt to play a significant role in future Christmas tree production.

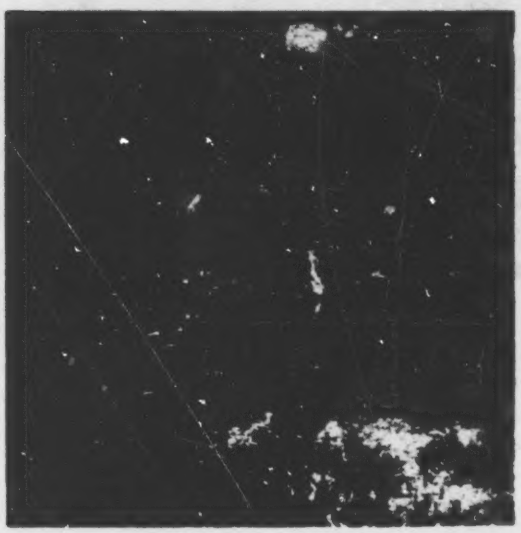
1. **Noble and Shasta red firs.** These species have excellent needle retention and very attractive foliage.

These species are grouped here together because their appearance, cultural responses and site preferences are quite similar. They grow naturally at 2,500 to 5,500 feet elevations. Branch and needle structure is stiff and strong enough to withstand heavy snows in their natural habitat. They have characteristic well-branched whorls with rather short internodal brances and open internodal spaces between whorls. The greater assets of both noble and Shasta red firs are attractive, nonshedding needles and a stately appearance provided by a formal, uniform branching habit. They are easily decorated with hanging Christmas tree ornaments such as colored glass balls and tinsel. They are also adaptable to flocking with artificial snow.

Noble fir is a native of the high Cascades and Coast Ranges of Washington and Oregon. Its northern range limit is near Stevens Pass in the north-central Washington Cascades.Its southern range limit is the Umpqua-Willamette divide in southern Oregon where noble fir blends and hybridizes with Shasta red fir.

Shasta red fir is a native of the high Cascades and Siskiyou Mountains of southern Oregon and northern California. It forms a transition species between noble fir and California red fir and hybridizes with each where their ranges overlap.

Both noble and Shasta red fir species have produced beautiful, desirable plantation-grown Christmas trees when grown on suitable sites and properly cultured. Where one species grows well, the other is likely to succeed. Noble fir usually grows slightly faster than Shasta red fir, but Shasta red fir is somewhat more tolerant of dry soil conditions. Needles of noble fir are generally considered more durable than those of Shasta red fir. They are darker green, stiffer and more densely arranged on the twig. On the other hand, Shasta red fir develops a narrower, more "self-shaping" crown than noble fir. Growers with suitable planting sites should, perhaps, try both species and give future preference to the one that responds the best.



A noble fir (left) is compared with a Shasta red fir (right) of the same age. Although these species are quite similar, the Shasta red fir is typically somewhat narrower, slower growing, more drought resistant, and about one week later in bud bursting.

Noble and Shasta red firs are very particular about their growing site. They prefer level to gentle northerly and easterly slopes where climatic conditions are coolor and soil is rich in humus, moist and well drained. They do not tolerate heavy compacted clay soil, high water tables, heavy grass sod or frost pockets. Cool moist conditions preferred by these species do not imply overhead shade. Like all other Christmas tree species, they develop best under open sunlight without root competition from larger trees, brush, grass and weeds.

A recently completed provenance test for noble fir and Shasta red fir provided much needed information about best seed sources for Christmas tree production.[1] The results follow:

a. The three best noble fir seed sources, in descending order for overall quality and vigor, were the Siletz River drainage in the north-central Oregon Coast Range; the Kalama River drainage near the southwestern slope of Mt. St. Helens in southwestern Washington, and Baw Faw Peak in the south-central Washington Coast Range.

b. The best Shasta red fir seed source was the Siskiyou Mountains west of Grants Pass, Oregon. No other Shasta red fir source rated even close to it for overall growth rate and quality.

c. The four top-rated seed sources listed above developed good trees over a wide range of climates, latitudes, elevations and soil types in the five western Washington and western Oregon test plots.

d. Ranking for the above top-rated strains did not change appreciably over the last four years that they were evaluated. This led us to believe that quality and growth rate characteristics first become evident when the trees are only 3 or 4 feet tall, and that they do not change much as the trees develop to heights of 6 to 8 feet.

e. Shasta red fir should be avoided on wet soil types. It was more susceptible to root rots than noble fir and also should not be planted near patches of bracken fern. Bracken fern is the alternate host of *Uredinopsis pterides*, a damaging true fir needle rust that infects Shasta red fir much more than noble fir.

f. California red fir is rated very low in the two test plots where it was located. Its greatest weaknesses included extremely slow growth and poor color. Growers are well advised to plant the Grants Pass strain of Shasta red fir instead.

g. Growers should make every effort to obtain noble fir and Shasta red fir seedlings from the general vicinity of the highest rated seed sources. The poorer seed sources would yield many fewer merchantable trees per acre. At the same time, they would increase growing costs because of longer rotations and extra pruning efforts to correct erratic growth. One of the test plot evaluators, an experienced and successful noble fir grower, summed up his observations with the following comment: "Regardless of how good my site or how much effort I put into culturing, I'd lose my shirt trying to develop Christmas trees from unsuitable seed sources."

2. **Grand fir.** Grand fir grows naturally in western and eastern Washington, and western and northeastern Oregon at many elevations. It is also found in southern British Columbia, northwestern Cali-

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[1] Bernard S. Douglass and Frank A. TerBush, U.S. Forest Service, Portland, Oregon. *Final Report of Provenance Test for Plantation-grown Noble fir and Shasta red fir for Christmas Trees* (August 1977).

fornia, northern Idaho, and western Montana. Grand fir, like Douglas-fir, has many racial variations over its wide geographic range. These inherited differences include growth rate, disease resistance, needle retention, needle form, needle color, and other characteristics that are important to Christmas tree growers. One example is the needle arrangement differences of West Side and East Side strains of grand fir. The West Side strains usually have needles arranged in two single flat rows on the twig. many East Side strains have two double rows on each twig and the needles sometimes spread upwards somewhat like a noble fir.

Grand fir from suitable seed sources are beautiful Christmas trees. They are usually priced on the Christmas tree market between noble fir and sheared Douglas-fir.

Some West Side plantations of grand fir become heavily infested by *Uredinopsis pterides* (a needle rust) when the trees are planted near patches of bracken fern, the alternate host of this fungus. It causes shedding and discoloration of needles on grand, Shasta red and concolor fir. The problem is serious enough that some growers have completely eliminated their grand fir plantations and converted to noble or Douglas-fir. Others have solved the problem by the elimination of all bracken ferns within about 500 feet of their grand fir. This can be accomplished by spraying the ferns with the selective herbicide "Asulox" in July and August.

Another serious disease of grand fir is *Rhizosphaera pini*. It causes all or portions of the needles to turn red. Some trees are more susceptible than others.

A Christmas tree provenance test was established in 1968 to test and compare 24 grand fir strains from Oregon, Washington, California, Idaho and Montana.[2] Evaluations were made on five test plantings in western Oregon and Washington. They were based on vigor, Christmas tree form, needle attractiveness, insect and disease resistance, and lateness of flushing. The highest rated seed source in all test plots was that from east of Grangeville in the central panhandle of northern Idaho. Next best seed sources in descending order were near Pend Orielle, Idaho; Hamilton, Montana, and Pomeroy, Washington. An interesting observation was that strains from East of the Cascade summit produced better Christmas trees in West Side plantations than the native West Side strains. Needles on the better East Side strains were noticeably superior for density, upright arrangement and color.

3. **Exotic species.** Too little is known about the exotic species to recommend planting them except on a limited trial basis. Red fir (*Abies magnifica*) from the Sierra Nevada mountains of California is similar in appearance to Shasta red fir, but much slower growing. Therefore, Northwest growers have little incentive to plant this species.

Fraser fir (*Abies fraseri*) from the southern Appalachian Mountains is a popular and attractive Christmas tree of the eastern United States. It grows quite well in Oregon and Washington, but develops even slower than noble fir and is very susceptible to damage by the balsam woolly aphid. Most promising of the overseas exotics are from the high mountains of Turkey or adjacent Asia minor countries and include Turkish fir (*Abies bornmuelleriana*), Nordmann fir (*Abies nordmanniana*), Sicilian fir (*Abies scilicica*), and Trojan fir (*Abies alba* var. *equi-trojani*).

C. MATCHING SPECIES TO SITE

The two high elevation true firs, noble and Shasta red fir, require more moisture and cooler growing conditions than do grand fir, Douglas-fir and pines. At the same time, noble and Shasta red fir require well drained soils to prevent root rot diseases. In low elevation Christmas tree plantations, best growth response can generally be expected on gentle slopes with northerly to easterly exposures which are not subject to severe summer heat and drought. However, their ability to survive on southerly and westerly exposures improves with higher elevations or where summer rainfall is heavy and summer temperatures are moderate. The probable reason is that the cooler, more moist sites come closer to the climatic conditions where the species grow naturally. Experience has shown that their chances for survival and growth response are likely to be better on a foothill field at 1,000 foot elevation than on a lowland field only a few miles away, assuming all other conditions are the same.

Grand fir requires greater summer moisture and coolness than Douglas-fir or pine. However, they are less demanding in this respect than noble fir or Shasta red fir. They appear to respond equally well on high or low elevation plantations, but prefer cooler, more moist sites. Level to gently sloping northerly and easterly exposures are usually most favorable for low elevation plantations.

Grand fir will tolerate wetter soil conditions than Douglas, noble or Shasta red fir. Some growers use grand fir to fill in excessively moist portions of their fields where these other species died from root rots. Grand fir also tolerates shady areas of a plantation, for example, along the fringe of adjacent stands of timber. This is not to say that grand fir prefers high water tables or shade. They merely tolerate it better than most other species. Grand fir develops best quality in open sunlight and well drained soils.

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[2] Bernard S. Douglass. U.S. Forest Service, Portland, Oregon. *Final Report of Grand fir Provenance Study to Rate Inherited Christmas Tree Characteristics of Various Seed Origins within the Natural Range of the Species* (January 1, 1974).

Christmas tree growers sometimes have several site conditions on a single planting area. For example, a ridge running east and west through a field contains both north and south exposures. In this case, the north exposure is usually best for planting true fir Christmas trees, but not usually best for pines and Douglas-firs. A U.S. Geological Survey topographical quadrangle map is useful to determine direction and degree of slope for matching species to site.

Opportunities to establish true fir plantations East of the Cascades are limited by excessive heat and dryness. Planting moisture-loving species such as noble and Shasta red fir on east side sites is a waste of time and money! Even if the trees are watered frequently, low humidity and temperature extremes will cause poor growth and dieback. Native strains of grand fir may be a good prospect for east side growers providing it is not planted on drier sites. Its best chances for east side survival are northerly and easterly exposures at higher elevations where grand fir grows or once grew naturally.

D. PLANTING

True fir seedlings, like any other species, require sunlight and adequate moisture. They should always be planted on bare, freshly and cleanly cultivated ground. Fields infested with blackberries, quack grass, Canada thistle, or bracken fern should be avoided until these have been eliminated by chemicals or repeated cultivation. Rank growth or grass and weeds during the spring and summer months will shade and distort the newly planted seedlings and deplete moisture in the soil. Old fields with heavy sod or weed cover should be disked as often as necessary during the summer and then fall plowed to control grass and weeds; then disked and harrowed the following spring just before planting. This will cause sod and other heavy organic matter to break down and decay. It will also eliminate new growth from seeds and root sprouts.

This spring-tooth cultivator is shredding old roots and loosening the soil in preparation for disking, harrowing, and tree planting. Several months previously, a heavy land clearing disk was used to uproot and pulverize stumps from a previous crop of Christmas trees.

Fields formerly planted to strawberries or other row crops sometimes become heavily infested with root-eating insects or larvae such as June beetle larvae and strawberry root weevils. Intense cultivation at least one year prior to tree planting will starve out most of these pests.

Three-year-old bare root planting stock (2-1 or 3-0) is usually recommended. The extra cost compared to two-year-old seedlings is justified by more rapid development and decreased first year's mortality in the plantation. Seedlings with small diameter stems and weak tops or root systems should be sorted out before planting. These can be either discarded or developed for an additional year in a transplant bed which provides a handy source of seedlings to replace mortality in the field. Transplant beds may also be used to develop 2-0 seedlings to larger 2-1 stock for next year's planting. Although some growers develop their own transplant beds at home, most growers find it pays to contract his job to a commercial nurseryman who can often do a better job at less cost.

Bare root planting stock is usually packed in waterproof bags or cardboard boxes at the nursery for convenience during shipment. Wet moss or other absorbent material is placed around the roots to protect them from drying. Bags or boxes of trees should be stored temporarily outdoors in a cool, protected spot. Unless trees are planted within a week after delivery, they should be either (1) removed from the bag or box and heeled in where there is sufficient moisture, shade and protection from drying winds; or (2) stored in a 34° to 38° F. cold storage room until ready to plant. Opened, partially used bags or boxes require occasional sprinkling or high humidity cold storage conditions to prevent drying.

Container grown seedlings have become available in recent years. Growing seedlings in containers has, in some cases, reduced the time needed to grow the kind of large, vigorous noble and shasta red fir seedlings from 3 to 2 years. Before giving your seed to a greenhouse operator, be sure that

A home seed bed is one means of insuring availability of the best seed source. It also insures a fresh, adequate supply of planting stock. The bed on the left is being sown with noble fir seeds. The bed on the right contains one-year-old seedlings.

he/she can meet your particular specifications for size and vigor.

Planting, whether by hand or machine, requires special techniques for good survival. Spring planting is usually preferred to fall planting, especially on clay loam soils which are susceptible to frost heaving conditions.

A 5-foot by 5-foot spacing is commonly used for producing the popular 6- to 7-foot tree heights. Some growers prefer somewhat wider spacing up to 5½ by 5½ feet to permit easier operation of their equipment between the rows or to provide more open sunlight around the lower branches. A few growers have increased the yield in their true fir plantations by spacing the trees about 3 feet apart within each row. Every other tree is harvested for table top size when they start to crowd. The balance of the stand is developed into larger sized trees.

Perfect spacing of trees to form check rows in each direction has the advantage of permitting cultivation and mowing in two directions. However, many growers do not believe the additional cost of check row planting is justified. They prefer instead to space the trees randomly in straight rows and rely on chemicals or one-way cultivation and mowing to control grass weeds.

When check rowing is the preferred method, it can be accomplished by premarking the cultivated field in squares or hand planting along a wire marked at proper intervals. Machine planting is much faster and usually somewhat less costly than hand planting, but it makes check rowing more dificult.

Unless helicopter yarding is planned, roadways will be needed through the plantation to give adequate access. These can be provided by skipping the planting of two adjacent rows of trees at intervals of every 20 or 30 rows.

E. CONTROL OF COMPETING VEGETATION

True fir Christmas tree plantations should be kept free of grass and weeds for the entire rotation. Grass and weed competition harms trees in four ways:

1. It forms a canopy of shade that suppresses and deforms the lower branches. open sunlight is required for adequate growth and attractive needles;

2. It depletes moisture and nutriments from the soil. Adequate summer moisture and nitrogen is required for good growth, color and survival;

3. It provides a habitat for meadow mice, gophers, rabbits and other destructive rodents, and

4. Accumulated dry grass and weeds create a fire hazard.

Frequent mowing or shallow cultivation between the rows was, until recent years, the most common practice for controlling grass and weeds. herbicides such as atrazine or Velpar are now either replacing or supplementing cultivation on most plantations. Chemical weeding usually proves less costly and more effective than just mowing or cultivation. Moreover, they permit controlling vegetation around the base of the trees that mowers and tillers cannot reach.

Atrazine has been the most widely used herbicide to control grass and weeds in Northwest Christmas tree plantations since the early 1960's. Atrazine is most economical when sprayed as a wettable powder. It is also available in liquid form, which requires no agitation in the spray tank. It is effective both as a pre-emergent spray (kills grass and seed sprouts as they germinate) and as a post-emergent spray (killing existing cover of grass and weeds). Atrazine should be applied uniformly over newly planted areas as soon as possible after planting, making sure the soil has been firmed adequately around the root systems. it usually should be reapplied annually in early March. Atrazine can be applied directly over dormant trees, even those that are newly planted, without causing damage. In fact, trees metabolize this chemical and often show improved color and growth after its applications.

Effective grass and weed control conserves soil moisture and prevents shading of lower branches. This practice shortens the rotation and at the same time improves color, vigor, and bud formation.

Usual rate of application is about 4 pounds per acre (bag weight) on sandy or gravelly soils and about 5 pounds per acre on heavier clay-loam soils. However, rates of up to 10 pounds per acre on clay soils and 7 pounds per acre on sandy soils may be necessary to control moderately atrazine-resistant plants such as quack grass, perennial ryegrass, tarweed and Queen Anne's lace. Atrazine is usually applied as a wettable powder by helicopter, airplane, or tractor-drawn boom sprayer equipped with agitators. Some growers reduce erosion on slopes by planting on the contour and spraying in strips between the tree rows or 3-foot circles around individual trees; then mowing the intervening grass strips. However, broadcasting the entire area will usually save time and money in ordinary situations.

Sometimes atrazine-resistant vegetation such as Canada thistle, wild blackberry and orchard grass gradually invades a plantation after the third or fourth growing season. It can be held in check by mowing or shallow cultivating between the rows but a more permanent solution is completely eliminating the vegetation by means of a directed spray. Your county extension agent or chemical company field man can recommend the most effective herbicide for the particular species that has become a problem. If mechanical spray equipment is used, it must be sufficiently narrow to operate between the rows without causing mechanical injuries to the trees. The trees should be basal pruned in advance to avoid chemical contact.

A word of caution is in order where herbicides, such as atrazine, are applied year after year. Some growers are beginning to suspect that chemical buildup in the soils can be detrimental to tree growth. It is probably wise to use only as much chemical as absolutely necessary, and to rotate from one herbicide to another over time to prevent unexpected or possible adverse chemical buildup. Several new and promising broadcast spray herbicides have been developed to supplement atrazine in true fir plantations. Check with your local county extension agent or chemical company field man for brand names, methods of application and season to apply.

Subterranean clover was established between the tree rows to raise the nitrogen level of the soil, control erosion, and prevent muddy harvesting conditions. Note the circles of bare ground around the driplines where atrazine was sprayed to reduce competiton for sunlight and moisture.

F. PROTECTION

1. **Insects.** Aphids are the most troublesome insects in true fir Christmas tree plantations. Grand fir and noble fir are both susceptible to large, long-legged black aphids (*Contarinia spp.*) that gather in clusters on the stems and leaders. The aphids feed on the sap and reduce tree vigor. They also secrete a honeydew on which an unattractive black mold grows on the twigs and needles. Another species imported from Europe, the balsam wooly aphid (*Adelges spp.*) is particularly partial to grand fir. This aphid causes swollen, stunted and deformed trees. Aphids may be controlled by spraying with malathion, thiodan or cygon. Aphid control is more effective, less costly and less damaging to the tree quality when it is carried out at the very first sign of an outbreak. Do not wait until a plantation is badly infected. Early infestation can usually be controlled by spot spraying individual trees, whereas heavy infestations may require aer-

ial or boom spray applications.

Grand fir usually requires spraying every year to control aphids that cause stunting and contorting of leaders and branch tips. The insect can be effectively controlled by spraying with cygon when the new growth is about half elongated. A back pack or tractor operated mist blower gives good foliage coverage with this systemic type aphicide.

2. **Diseases.** Various diseases infecting needles, stems and roots have been a serious problem in many true fir plantations. Some of the more troublesome diseases are decribed below:

Needle rusts cause elongated white or yellow spore pustules on the undersides of the needles during early summer. By late summer or early fall, the infected needles usually develop brown spots and sometimes shed from the twig. Needle rusts are cyclic in the severity of occurrence. Heavy infestation years are believed to result from wind and moisture conditions that encourage spores to spread and cling to damp needles.

A particularly common and serious rust disease on concolor, Shasta red fir and grand fir is bracken fern rust (*Uredinopsis pterides*) which alternately infests bracken fern. This rust can be recognized by white pustules on the underside of the needles. Susceptibility to needle rust varies with species. While grand fir, concolor and Shasta red firs are very susceptible, noble fir is quite resistant. Unless a grower plans to eradicate all bracken fern within 500 feet from the trees, he should avoid planting the susceptible true fir species and switch to noble fir.

Another species of true fir rust (*Peridermium spp.*) forms yellow spore pustules on the underside of the needles. Huckleberry plants are the alternate hosts.

No practical chemical treatments are known for rusts. Planting rust resistant species is the simplest solution. The only other practical solution might be eradication of the alternate host plants for the particular species of rust that is infesting the trees.

Stem canker (*Phomopsis*) cause swellings or roughened areas of dead cambium that girdle the main stem. Shasta red firs, and to a lesser extent, noble firs are quite susceptible. This disease is commonly associated with poor site conditions such as very dry soils, water logged soils, or heavy grass competition. Planting trees on moist, but well drained, fertile soil with north and east exposures, and then maintaining good grass amd weed control are the most effective preventative measures. Once infection sets in, salvage as many trees as possible before they die. Replant problem areas with more resistant species such as grand fir, Scotch and shore pine.

Rust infection is followed by browning and shedding of needles during late summer and fall.

3. **Excessive Soil Moisture or Drought.** Noble and Shasta red fir have a narrow tolerance for moisture. Mortality unrelated to insects and diseases has been observed for both species when winter wet spots and summer drought occur. We are indebted to the State of Washington Department of Natural Resources for the following information on this subject.[3]

Noble fir and Shasta red fir, but particularly Shasta red fir, show poor growth and high mortality on excessively wet soils. First symptom of damage is slowing of growth followed by yellowing and eventually browning of the entire crown. The cause of dying may at first be puzzling to the grower because the stems, branches and needles show no outward damage other than a gradual drying.

However, examination of the roots shows dead cambium without evidence of a primary disease, although a noticeable root swelling sometimes occurs just below the ground line. The best solution is to refrain from planting these species in wet areas. If wet spots must be planted, consider Scotch or shore pine, which are relatively tolerant of wet soils.

Both species, but Shasta red fir to a much lesser degree than noble fir, are susceptible to damage from drought. Two types of drought — soil and atmosphere — may occur. Each will be described separately.

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[3] Kenelm W. Russell, Forest Pathologist, Washington State Department of Natural Resources, reports of May 2 and May 16, 1972.

Soil drought symptoms are somewhat similar to those caused by root rots. Trees tend to droop and fade during extended periods of drought. The new growth sometimes takes on a "shepherd's crook" appearance. The crown dies rather evenly and eventually turns red. The roots are the last to die and sometimes appear outwardly healthy or at least not diseased, after the crown dies. The best solution is to keep the plantation free of grass and weed competition and to water at 2- to 4-week intervals during periods of extended summer drought. If watering is impractical, plant trees only on cooler, more moist sites. Good prospects are northerly and easterly exposures, higher elevations, and well-drained soils with good moisture retention.

Atmospheric drought occurs when needles lose water faster than it can be replaced by the roots. It most frequently occurs during periods of hot, dry summer winds or drying winter winds when the ground is frozen. Trees are particularly susceptible in early summer when the new growth is still succulent and can be dehydrated very easily. In this case, the tips of the tender needles or shoots die back, but the tree usually recovers. Symptoms of atmospheric drought are dying and browning of the needles from the tips back. The tree may look like it is seared, particularly on the top and exposed sides. Severe conditions may cause the entire tree to die from the top down, with the roots being the last portion of the tree to die. Atmospheric drought is associated with adverse weather conditions and is, therefore, difficult to predict or control. One solution is to plant pines instead of true firs on exposed ridge tops and southwest exposures where winds or temperature extremes are most likely to occur.

4. **Animals.** Cattle, horses and sheep are not compatible with Christmas tree growing on the same sites. The animals browse the succulent tips, trample seedlings, and damage the branches by rubbing. Fencing costs can be minor when compared with potential losses to such damage.

Deer and elk do similar damage, particularly where plantations are adjacent to wooded areas with overstocked game populations. Your State Game Department can offer advice on protecting your tree farm from wild game animals.

Small rodents are frequently more damaging than any other types of animals. Meadow mice may girdle smaller trees near the groundline and pocket gophers may eat and girdle the roots. The best solution in either case is to control grass and weeds which provide feed and cover. Heavily gopher-infested areas may also require an intensive baiting or trapping program. People from the State Game Department, U.S. Fish and Wildlife Service, and State Universities can provide advice and assistance.

5. **Fires.** Fire damage is not a serious problem on plantations where flammable grass and weeds are effectively controlled by herbicides or cultivation. Where a fire hazard condition exists, vegetation-free firebreaks should be cultivated or bulldozed around the perimeter and through the fields to dissect them into smaller fire control units. Fire lanes should be maintained to expose mineral soil until the existing vegetation finally decays and future growth of grasses and weeds is checked.

6. **Trespass.** Theft is less likely to occur when trees are growing on your home property and can be watched. The best solution for absentee owners is to establish their plantations on a private road with controllable access. Where this is not possible, signs, fences, and locked gates should be planned. Problem areas may require patrolling during the Christmas tree cutting season. Cooperative neighbors and local law enforcement officers can be a deterent to seasonal trespass.

G. SHAPING THE TREES

1. **Overall Objectives.** Two very important ingredients on which a profitable Christmas tree operation depends are time and tree quality.

Time, or rotation, is the number of growing seasons required to grow a crop of Christmas trees. Assume that grand fir seedlings were field planted in 1981 and then harvested over the three year period of 1987, 1988 and 1989. The rotation would be nine years or the number of growing seasons from spring of 1981, when the trees were planted, to December of 1989 when the last trees in the field were harvested.

All things being equal, the shorter rotation usually produces greater profits because a larger number of trees per acre per year can be grown under a continuous cropping program. The sticker in this theory, of course, is that all things are not always equal. With very short rotations, low quality often results from excessively long leaders and light density.

A modified overall objective might be stated as follows:

Strive for the shortest possible rotation that produces a high proportion of U.S. No. 1 and better grade Christmas trees with desired size, density and taper. (Taper is defined as the width of the tree expressed as a percentage of the height.)

The following describes various cultural practices used to produce high quality true fir Christmas trees. They are particularly applicable to western Oregon, western Washington and southwestern British Columbia. To a lesser degree, such practices should also be suitable to other regions as well. An interesting observation has been noted during the authors' travels to principal Christmas tree producing areas throughout the United States. It is that many time-proven cultural practices are equally effective in the North and South as well as the East and West.

2. **Correcting Multiple Leaders.** An important objective of skillful Christmas tree culture is to maintain only a single leader throughout the development period of the tree. When more than one leader forms, all except the best one should be cut flush with the main stem. Considerations for selecting the best leader are length, vigor, erectness, central position and completeness of terminal bud set. If a multiple leader has five terminal lateral buds and another has only four, save the five-budded leader to insure a balanced, five branched top whorl next year.

Multiple leader removal should be done whenever they occur. This is usually the only type of pruning required during the first 2 or 3 years after a plantation is established. Multiple leader culture is not very time consuming in young stands because only a minority of the trees normally form multiple leaders. However, they should be cut out every year. Postponing this job may cause crowding and suppression of lateral branches arising from the multiple stems. It also results in crooked stems because multiple stems tend to lean away from each other.

Multiple leaders may also form towards the end of the rotation after excessively long leaders have been pruned back. These multiple leaders can often be prevented on pruned leaders by cutting the leader above a *single* internodal bud which is situated an inch or more above an internodal bud cluster. The single becomes a terminal and the cluster grows into a false whorl. Cutting the leader just above the bud cluster itself frequently causes multiple leader problems because no single bud in the cluster is in a dominant position to form a new leader.

If multiple leaders form from a cut leader despite these precautions, it is best to retain the lowest one on the stem. This avoids unattractive, upright stubs below the leader that is retained.

Suckers are similar in appearance to multiple leaders except that they rise vertically from an upturned lateral branch or sprout below the top whorl. (One might quote the late P.T. Barnum who advised: Never give a sucker an even break!) Complete removal of a sucker is almost always the preferred solution. Removing only the top portion seldom arrests its abnormally vigorous and haphazard growth characteristics which detract from the appearance of a tree. One exception to the toal removal of a sucker is the retention of a single outpointing branch near its base to fill an opening in the crown.

3. **Basal Pruning.** This is the removal of unwanted branches between the bottom whorl of the Christmas tree and the ground. The pruned stem provides a reasonably straight handle of at least 1 inch per foot of tree height for insertion into the tree stand. The stem should be pruned sufficiently high to avoid serious defects, such as incomplete bottom whorls and crooked stems. Most growers strive for a minimum distance of about 10" between the bottom whorl and the ground. This allows sufficient leeway in handle length to help prevent cutting into the ground and dulling the chain saw when the trees are felled. The branches should be cut flush with the stem to avoid both stubs and heavy scars. Hand pruners, and sometimes short machetes or heavy knives, are used for basal pruning.

The selected bottom whorl should preferably contain five or more uniform, well-distributed branches in a main whorl. Sometimes, however, the only available prospects for forming a bottom whorl contain only three or four branches instead of five. In such cases, the deficient whorl must be "backed up" by several strong internodal branches just below or above the main whorl to complete the whorl pattern and help fill in the gaps. Distance between the ground and the selected bottom whorl should be more than the usual 10" if heavy competing vegetation is not controlled.

Basal pruning provides several other important benefits besides forming a handle. It defines the usable portion of the crown, exposes the bottom whorl to sunlight, and it facilitates mowing, cultivating, spraying, fertilizing and harvesting.

Last, but not least, basal pruning provides an effective means of shock treatment to help control future excessive leader growth. Basal pruning alone frequently provides sufficient shock to prevent excessively long leaders until the tree is ready to

Basal pruning improves quality by forming an adequate handle above a strong, symmetric bottom whorl. Unwanted lower branches should be cut flush with the stem below the selected bottom whorl.

harvest. If excessive leader length develops despite basal pruning, most growers follow up with leader pruning to attain proper length, together with light side shearing to prevent overly-wide crowns.

Some growers use additional shock treatments such as root pruning, leader scarring and basal scarring to slow future growth. These treatments are not generally recommended because they reduce the normal vigor of the tree and it is difficult to predict the amount of growth response. A better method is to redirect the excessive growth energy to the over-all crown area of the tree by shearing or leader pruning.

It is important to know when to start basal pruning. If done when the tree is too small, it may over-shock the tree and appreciably stunt the leader growth for another year or two. When postponed too long, excessively long leaders may result, as well as increased costs due to the difficulty in cutting the heavy bottom branches.

One good rule of thumb for the proper time to basal prune a true fir is to wait until a leader first develops a length between 12 and 16 inches. This stage of development frequently occurs after three or four growing seasons in the plantation. Basal pruning may be done at any time of year, but extra care must be taken to avoid breaking tender shoots during the succulent stage of new growth.

If complete basal pruning would be so severe as to cause overshock, it could be done in two stages. The first stage should establish the bottom whorl of the Christmas tree and progress downward from this point until the desired number of branches were removed. Defer pruning the remaining lower branches until the tree has made another season's growth.

This noble fir is not ready for basal pruning. Annual growth is less than 12" per year. Premature basal pruning would shock the tree and unnecessarily prolong the number of years required to attain a marketable height.

This noble fir is ready for basal pruning as indicated by the 14" leader. If the tree is not shocked at this time, next year's leader is likely to grow excessively long.

Basal pruning during the previous year effectively controlled growth of this noble fir. Had the tree not been shocked, indications are that the leader would have been about 18" long instead of 13".

A height-growth control study for noble fir[4] shows growth retardation of 21% during the first growing season after removing 50% of the live branches by basal pruning. Retardation was even more, 25%, during the second growing season, and continued to a much lesser degree into the third growing season after treatment.

4. **Replacing Lost Leaders.** Abortion of the center bud on the tip of the leader is a frequent and very troublesome problem on true firs. This is usually caused either by freezing or by bud boring larva. During the succulent stage, existing leaders may also be broken off by birds, animals or equipment. Whenever a leader is broken off near its base or fails to develop, serious conformity problems result unless remedial action is promptly taken. One major problem is that the lateral branches absorb the growth energy that would normally go into the leader. This causes the crown to become abnormally wide. Tight side shearing is required to maintain a narrow taper until a new top develops. Another problem is that several branches in the top whorl turn up and try to form a new leader. This spoils the conformity and balance of the top whorl. Several solutions are offered below. Although they usually give "less than" desirable results than a natural leader, they often make a saleable tree from one that otherwise would become a cull.

a. Cut off the entire top whorl above a strong lone internodal branch. The best time to do it, if you have a choice, is during the late succulent stage. Leave a base 2" stub above the internodal branch. Bind the internodal branch tightly against the stub in a vertical position with a couple of wraps of plastic flagging. Stretch the flagging before wrapping to insure against slipping or additional stretching. Remove the stub and flagging several months later when the new leader has "set" in a vertical position.

b. Select two branches in the top whorl that are exactly opposite each other. Draw them together in a vertical position. Bind them tightly together near their bases and near their tops with a couple of wraps of stretched, plastic flagging. After several months when they have set in a vertical positon, remove the flagging. Then, select the best leader and cut out the other one.

Note that a leader formed by an upturned branch tends to produce a three-sided, branch-like whorl the following year. This three-sided appearance can be de-emphasized by removing the terminal bud cluster from the upturned branch and relying on the lone internodal bud *facing the leader scar* to produce next year's leader.

This last remedy is especially effective if small buds or sprouts are beginning to show where the top leader bud aborted or was broken off. Cut the top whorl back severely, but leave two or more buds on each branch stub to keep it alive and well balanced. This will stimulate growth of several new leader sprouts, which will form multiple leaders. Retain the best multiple leader. Cut back the others

This Shasta red fir grades below U.S. No. 2 because of excessive whorl spacing. Timely shearing to improve density could have resulted in a U.S. Premium or U.S. No. 1.

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[4] Study made in Clackamas County, Oregon by Bernard Douglass, Alvin Parker, Clayton Wills, and Harry Rounsefell, 1961-1963.

severely or remove them completely, depending upon the best overall balance and appearance.

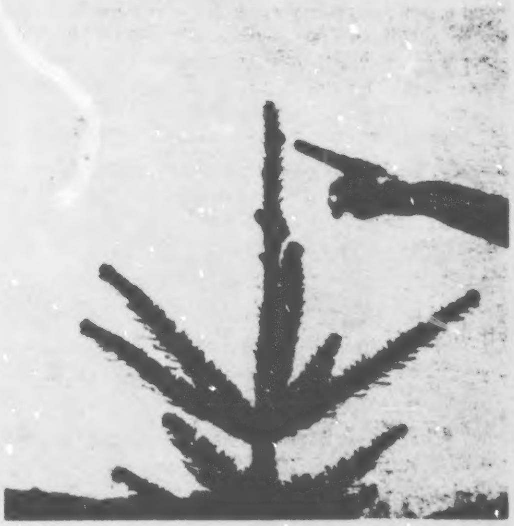
5. Leader Pruning and Side Shearing Techniques.

a. **Definition.** Leader pruning consists of cutting back excessively long leaders to adequate length. As part of the same operation, unwanted multiple leaders are removed or shortened. Hand pruners are effective tools for this job. They permit close control in making the cuts in proper relation to the position of the internodal buds.

Side shearing consists of cutting back the tips of lateral branches to complete the cone shape to a desired taper. It is an effective means of correcting excessive crown width, lopsidedness and inadequate density when the trees do not naturally shape up well. Although many consumers still prefer the completely natural look of the unsheared tree, increasing numbers desire the more bushy, compact sheared type. In response to this changing market demand, most true fir growers now shear all or a portion of their true firs. Several types of shearing tools are used and include hand shears, shearing knives, hedge shears and electric and gasoline motor operated power clippers. Choice of tool largely depends upon the preference of the user. Knives are the most commonly used shearing tool at this time.

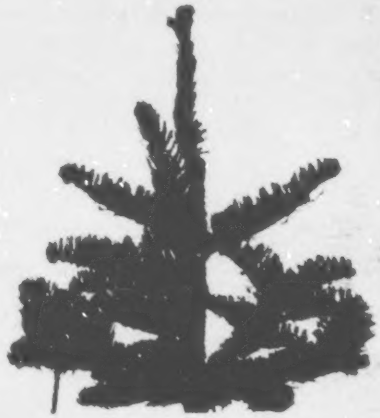
Some growers prune the tops of their trees as a separate operation before starting to shear the sides. Others combine both jobs as part of the same operation. In either case, the techniques are the same. Leader pruning should precede side shearing to establish the top of the cone and provide a guide for shearing the lower portion of the cone.

b. **Noble and Shasta Red Fir Techniques.** Ideal annual leader growth is 12 to 16 inches. However, it is usually better to retain natural leaders up to 17 or 18 inches in length rather than cut them back. Reason: the base of the new leader arising from an internodal bud or the top bud of a sheared leader sometimes forms an unsightly crook or offset called a "dogleg." The first year's terminal bud set of this new leader also may contain only three or four buds which produce an unsymmetrical top whorl. These leader shearing problems are more pronounced on noble and Shasta red fir than on other species. They can be minimized by shearing during the summer succulent stage when new growth is still brittle during its final stage of elongation, rather than later in the season. Succulent shearing allows the terminal bud to become more erect on the stem. It also frequently causes internal changes to occur in the bud structure which result in a normal five-bud terminal bud cluster the following year.



Pointed out is a top internodal bud on a Shasta red fir leader several months after it was succulently pruned to correct excessive length. Note that the bud has enlarged somewhat and has assumed a more erect position on the stem.

Detailed instructions for pruning excessively long leaders of noble fir and Shasta red fir follow. Locate a cluster of internodal buds on the leader, preferably about 12 to 16 inches above its base. Then try to locate a single internodal bud 2 to 4 inches above the cluster which can form the new leader. If more than one bud occurs at the desired level on the leader, pick all but one of them off. If such a bud cannot be located above the cluster, select the top bud of the cluster.



A new leader formed from the top bud one year after succulent shearing. No top shearing is required at this time because the new leader is only about 14" long, reasonably upright and contains a terminal bud surrounded by a rosette of five lateral buds.

When the leaders are pruned during the recommended late succulent stage, the cut may be made only a fraction of an inch above the top bud.

If leader pruning was neglected during the succulent growth period, then it is better to do it during the late summer or dormant season than not at all. In dormant pruning, leave a 2" leader stub above the selected top bud. This will form a post for tying the new leader erect. In case it does not grow straight and vertical, tie the leader against the stub with stretched plastic flagging. If leader pruning results in multiple leaders, then remove all except the best one. An exception would be where complete removal of the competing leaders would leave an obvious gap in the branch structure. In this case, cut the unwanted leaders back severely just above an "out-pointing" bud.

Growers are frequently tempted to shear the tips of the top whorl to correct a flared shape near the top of the crown. However, a better practice in most cases is to defer shearing the top whorl for one year. This will permit time for the lateral branches to form nodal forks during their second growing season. Shearing above these forks will noticeably improve the symmetry and naturalness of the sheared branch structure.

Some growers, are apprehensive that the uncut branches in the top whorl will turn up and form multiple leaders if the leader is shortened. However, true firs react differently than Douglas-firs in this respect. The branches in the top whorl tend to remain in their original horizontal position following leader pruning.

After the leader has been sheared, it is almost always necessary to shear the sides of the tree for maintenance of good proportion and prevention of excessive width. Shearing also increases the crown density by diverting growth energy from the main branch tips to the internodal branches and inside buds.

Three methods of side shearing will be separately described — random shearing, fork shearing, and disbudding. More than one method may be practiced on a single tree to bring out its best response. For example, branches that need drastic shortening may be fork sheared; those that need only slight shortening may be random sheared; and those that need lengthening may be left unsheared in order to catch up with the others.

Cutting back the tips of the branches in the top whorl is a good practice for perfecting crown shape during the year of harvest. However, it is not recommended prior to the year of harvest unless the branches are abnormally long. Tip cutting virtually halts branch elongation for a year or two.

(1) **Random shearing** consists of narrowing and shaping the crown to a uniform cone by cutting all 1 year old branch tips that project beyond the general desired cone shape. Care should be taken to avoid cutting secondary branches along with the tips. This would spoil the balance of the branch structure which is very important to many noble and Shasta red fir buyers. However, no attempt is made to make the cuts in relation to the position of individual buds on the sheared branch tips. A thin, sharp shearing knife is the most commonly used tool, but a hedge shear or power clipper may also be used. Random shearing is the more frequently used method of shaping the sides of a tree. It is also the least costly method to perform and easiest to teach shearing crews.

(2) **Fork shearing** uses a hand pruner to remove tips of individual lateral branches. These branches are located just above a fork formed by a nodal branch cluster or oppositely arranged secondary branches. Sufficient branch tip should be removed to attain desired crown width and uniform cone shape. Heavy fork shearing may actually cut into 2 or 3 year old wood where extreme narrowing of the crown is needed. Appearance and resistance to splitting is improved when the cut is made just above a branchlet arising from the bottom of the main branch. This is true for oppositely arranged branchlets on the side of the main branch. A disadvantage of fork shearing over random shearing is the tendency of the forked branch to split out during handling and shipping, or during silver thaws.

(3) **Disbudding** consists of removing one or

Fork shearing removes individual lateral branch tips to improve shape and prevent excessively wide trees. New growth from secondary branches tends to form a fork.

more buds from the bud cluster at the tip of a main lateral branch. As a minimum, it picks off the terminal bud plus any bud arising from the top side of the bud cluster. Time can be saved by cutting or pinching off the entire terminal bud cluster. A few growers develop sufficient skill with a shearing knife to flick off the terminal bud cluster with extreme accuracy, but most growers depend upon using their fingers or hand pruners. Disbudding the tips of the largest main laterals enables a grower to improve the shape of the tree and stimulate internodal branch growth in such a subtle manner that the tree will appear to be unsheared. Disbudded trees have a wider taper than those that are random sheared.

c. **Conclusions from a Noble Fir Shearing Study.** A cooperative study of noble fir culture was made by the U.S. Forest Service, State of Washington Cooperative Extension Service, J. Hofert Company and member growers of the Northwest Christmas Tree Association. The study was to determine most effective and economical techniques for developing plantation-grown noble fir Christmas trees in western Washington.[5] All known methods of leader pruning and side shearing were compared during both the dormant and succulent seasons and with and without applying nitrogen fertilizer. The conclusions follow:

(1) **Shear or not to shear?** Nonsheared trees that shape up well are very attractive. then, why shear a plantation at all?

The biggest reason to shear is that only a small percentage of trees are naturally self-shaping. The others developed various problems such as lopsidedness, excessive flares, and excessive spans between whorls. With proper shearing and leader shortening, most trees that would otherwise become culls could be developed into highly salable U.S. No. 1 and Better grades.

A second advantage of shearing was narrowing the tapers for easier handling, more economical shipping, and a wider range of consumer acceptance.

A third advantage was increasing the crown density. Current market demand is toward bushier crowns.

(2) **Best Shearing Techniques.** The best overall shearing practice was random shearing with a knife. Both light and medium intensities of knife shearing gave excellent and approximately equal grade recoveries. The main difference was a narrower taper for medium shearing (69% taper vs. 82% for light shearing).

Advantages of random knife shearing over clipping individual branches with a hand pruner were less cost, greater speed, more perfect cone shape, and more positive control of percent taper.

(3) **Proper Leader Pruning Techniques are a Must for Quality Control.** Side shearing alone was not enough. When leaders exceeded about 16", they needed to be cut back to about that length to prevent excessive internodal spans. Ideally, a leader should be cut just above a single internodal bud located one to four inches above an internodal bud cluster.

An additional advantage of leader pruning was diversion of growth energy to internodal branches, which increased crown density.

(4) **Fertilizing with Nitrogen Increased Tree Quality.** Nitrogen fertilized trees were visibly better quality than unfertilized control trees. Nitrogen more than doubled the grade recovery of U.S. No. 1 and Better trees. In addition, the fertilized trees grew almost a foot taller than unfertilized trees in eight growing seasons. The visible benefits from fertilizing were darker green, longer and heavier needles. Fertilizing also increased the number of internodal buds and increased the caliper of stems and branches.

(5) **Dormant vs. Succulent Shearing.** Results of shearing the sides of trees were acceptable and about the same for both the dormant and succulent stages. However, shearing was somewhat easier and faster during the succulent season

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[5] Bernard S. Douglass, forester retired, U.S. Forest Service, Portland, Oregon, *Final Report of a Shearing and Fertilizing Study for Plantation-grown Christmas trees* (January 1977).

when new growth was still tender.

Cutting leaders during the succulent stage produced better results than during the dormant stage. The top bud on a succulently cut leader tended to become more erect and dominant during the course of the summer growing season, and thus was able to produce a relatively straight, even-whorled leader next growing season. Those on a leader cut during the dormant season usually formed a noticeable offset, commonly called a "dogleg".

(6) **Summary.**

(a) Shearing and fertilizing greatly increased the percentage of U.S. No. 1 and Better grade recovery. About half of the unsheared trees became U.S. No. 2 and culls, compared with only about ten percent of those that were sheared and fertilized.

(b) The most effective shearing technique was also the easiest and cheapest to perform. It consisted of light to medium side shearing to a cone shape with a knife and cutting the leaders back with a hand pruner to form a false whorl when their length exceeded about 16 inches.

(c) Side shearing was equally effective during the succulent and dormant stages of growth. However, leaders pruned during the succulent stage produced straighter future leaders from the top bud and more uniform whorls than those pruned during the dormant season.

d. **Grand Fir Techniques.** Three types of grand fir are produced in Northwest plantations: unsheared, light sheared, and heavy sheared. The unsheared and light sheared types are produced largely on slower growth sites. Acceptably short leaders may be attained on some trees by the shocking effect of basal pruning alone. Other trees do not respond sufficiently to basal pruning and require light cutting of the leaders and longer branch tips. Trees developed in this manner retain visible internodal spaces between whorls, a rather wide taper and a more or less natural look. Techniques for this light shearing of grand fir are about the same for those previously described for noble fir and Shasta red fir.

Heavy sheared grand firs are usually grown on faster growth sites where few trees develop adequate density without an intensive shearing program. These true firs can also be developed on low sites which are fertilized to stimulate growth rates. Heavy sheared trees are in growing demand by consumers who prefer trees with dense crowns and narrow to moderate tapers. The method of shearing is quite similar to that used to develop sheared plantation-grown Douglas-firs. The main difference is that grand firs are not usually sheared as tight as Douglas-firs.

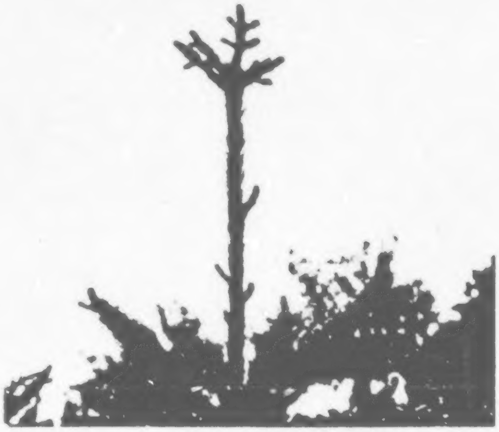
Instructions follow for developing the six- to eight-foot tall size:

(1) Shear the tips of the lower whorl only when the tree has developed two whorls above the handle. Do not cut back the leader until the total height of the tree exceeds about 4½ feet.

(2) When the total height of a tree above the base of an 8" handle first exceeds about 4½ feet, reduce the height to approximately 4½ feet by cutting back the leader. Make the cut above the single internodal bud located above a cluster of internodal buds. Grand firs develop more prolific internodal buds than any other true fir species. Lightly shear the sides of the trees to form a cone with a taper of about 50%.

(3) During the following year, and each year thereafter, cut the leader to about 12" long and continue side shearing to form a cone with about a 50% taper.

(4) During the last year of shearing, cut the leader to whatever length gives the best proportion. This is commonly eight to ten inches. At the same time, side shear very lightly to form a



A late summer flush of regrowth is shown on a terminal bud cluster. It most frequently occurs after irrigating or heavy summer rains. Regrowth sometimes occur only on one or two lateral buds. Shearing to correct the resulting unsymmetrical appearance is most effective if deferred until the late succulent stage of the following growing season.

stub-free, natural appearing cone. Lighter side shearing will expand the taper of the cone from about 50% to about 60%.

(5) Recommended season of shearing is during the late succulent stage after the new growth has fully elongated. Shearing the leader at this time causes the top bud to grow more erect during the summer. Where it is necessary to shear during the dormant season, leave a 2" stub above the selected top bud on the leader. This stub will serve as a post to bind the new leader into an upright position if it tends to lean.

e. **Conclusions from a Grand Fir Shearing Study.** A Cooperative study on culturing grand fir Christmas trees was completed in 1977 by the U.S. Forest Service, Washington State Cooperative Extension Service and members of the Northwest Christmas Tree Growers Association. The purpose of the study was to determine the most effective and economic techniques for developing plantation-grown grand fir Christmas trees in Oregon and Washington.

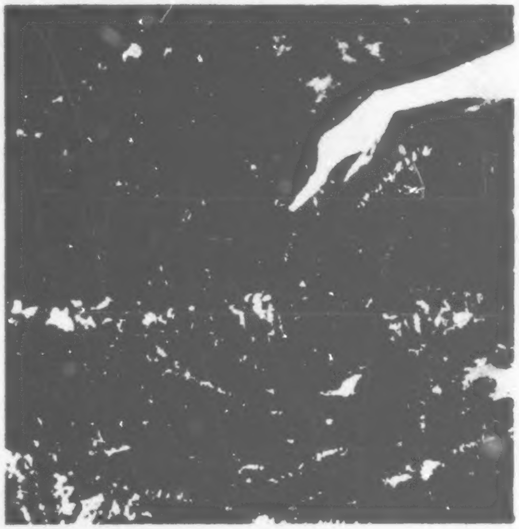
Two study plots were involved: one near Olympia, Washington, and the other near Hillsboro, Oregon. Various methods and seasons of leader pruning and side shearing were compared with and without fertilizing.[*] Results follow:

(1) From the standpoint of both grade recovery and shortness of rotation, the most effective shearing technique was light, random shearing with a knife to form a cone-shaped crown. Light shearing produced a 70% average taper and yielded 25% more premium grade six- to seven-foot trees than the tighter shearing to a 58% average taper.

(2) The most productive leader shearing techniques for developing the popular six- to seven-foot height was accomplished by cutting the leaders back to about 12" each year. This shearing was done once the pruned height of the tree exceeded about 4½ feet. Any trees less than 4½ feet tall were not leader pruned, but most of them were side sheared to narrow their taper. This leader pruning technique started producing six- to seven-foot, U.S. No. 1 and Better grade trees after seven growing seasons in the field. During this period, the trees received four consecutive shearings and three consecutive leader prunings. Two additional years of leader pruning and side shearing were required to attain merchantable size and quality for the slower developing trees.

(3) Succulent shearing, when the leaders were fully elongated but still tender, developed 36% more U.S. No. 1 and Better grades than dormant shearing. Succulent sheared trees developed straighter leaders.

(4) Fertilizing with nitrogen visibly improved vigor, color, and crown density. Thirty-seven percent more U.S. Premium grade trees were tallied on fertilized trees than on unfertilized trees.



Birds broke off the leader several months ago during its succulent stage. Note the tendency of the lateral branches of the top whorl to grow erect and form multiple leaders.

H. STUMP CULTURE

Stump culture is the practice of leaving a few limbs below the handle to keep the stump alive after the Christmas tree is harvested. Cutting back the tips of the limbs will stimulate growth of several vertical adventitious sprouts from the sides of stump. The most promising one is then selected to produce a new tree. The competing sprouts and branches are gradually removed to insure dominance of the selected sprout.

Stump culture is not recommended in plantations unless a special tree or seed source needs to be preserved. Too much time and labor is required to cut back the competing growth. It does have application in natural stands where new seedlings are lacking or difficult to establish. Using an established root system of a cut tree may actually reduce the time necessary to develop the next trees.

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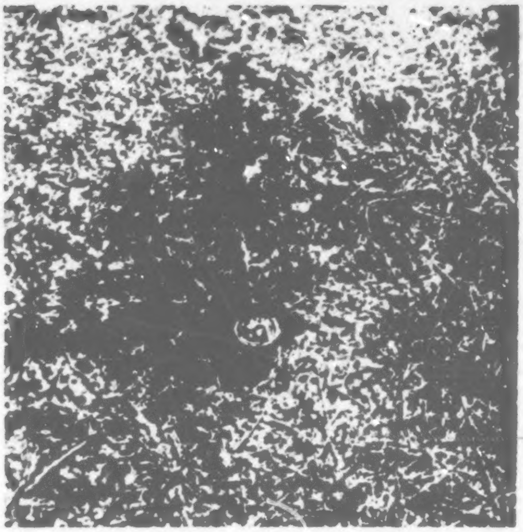
[*] Bernard S. Douglass and Frank A. TerBush, "Shearing and Fertilizing Study of Plantation-grown Grand Fir Trees," *Northwest Lookout*, September 1977.



Stump culturing is sometimes used to replace a cut tree without replanting. It consists of saving a few branches in the stump below the handle to keep the roots alive. Cutting back the branch tips will help force adventitious buds from the stump, which develop into a new tree much more readily than an upturned branch.

Four ounces of urea were spread under each noble fir to increase its vigor and bud production. Although the larger trees were improved, a number of smaller ones died from nitrogen shock. Mortality could have been prevented by adjusting the amount of fertilizer for each tree according to its size.

I. FERTILIZING

Some cleared lands, formerly under cultivation, contain sufficient nutriments for good Christmas tree vigor and color without fertilizing. However, chlorotic (yellowish) needles, sparse buds and excessively slow growth rates can occur in many true fir plantations even with good grass and weed control. This is a fairly reliable indication of a nutritional deficiency.

Fertilizers must be used with caution. Overdoses may injure the roots, cause excessive growth or stimulate rank growth of grass and weeds. Experimental applications of 1/16 to 1/4 pound (actual nitrogen) per six foot tree should be made to determine the least amount per tree needed to obtain desirable color and vigor. Heavier applications of fertilizers will probably be more necessary on clay soils than on sandy soils. Large scale applications should not be made until sufficient small trials have proven their effectiveness under local conditions.

Straight nitrogen fertilizers have in most cases proven equally effective and less costly than balanced fertilizers. Commonly used nitrogen fertilizers are urea, ammonium nitrate and ammonium sulphate.

Fertilizer should be scattered under the drip line of the tree in late winter or early spring before the buds have burst. Proper amounts of nitrogen will cause deficient trees to develop heavier, darker green needles and a noticeable increase of internodal buds after one growing season.

Increased leader growth will only be slight during the first growing season, but frequently doubles during the second. Therefore, the safest time to apply nitrogen on unsheared or lightly sheared trees is in March or April of the same year that the tree will be harvested. Another advantage of deferring fertilizing until the year of harvest is obtaining maximum color response which always occurs during the same year that the nitrogen is applied.

Another use of nitrogen is for stimulating vigor and growth of stunted or unthrifty trees on poor sites. Two precautions should be observed in fertilizing younger plantations.

a. Do not fertilize the same year that trees are planted. Roots at this time are easily damaged by even small applications of nitrogen.

b. Use nitrogen very sparingly on small trees. Overdoses will burn the roots. Trial applications should be made around the drip lines of a few trees to determine the correct amount to stimulate adequate growth without killing the roots. Perhaps try a tablespoon full for small trees after the first growing season in the field.

J. NUMBER OF YEARS REQUIRED TO GROW A MERCHANTABLE TREE

Rotations for growing true fir Christmas trees will vary with species, sites, and intensity of culture. Harvesting is usually spread over a period of three or more years because all trees do not develop uniformly.

The rotation ages shown below are considered average for intensively managed plantations on Site III lands. Estimated percentages of total cut for each year of an assumed three year harvesting period are also shown.

Percentages of Total Merchantable Trees Harvested at Various Plantation Ages

Species	Number of Growing Seasons					
	7	8	9	10	11	Total
	----- Percent of Total Harvest -----					
Grand fir	20	50	30			100
Noble fir		30	40	30		100
Shasta red fir			40	40	20	100

K. SEASONAL CULTURAL INSTRUCTIONS

1. **After First Growing Season.** Concentrate only on keeping trees alive, healthy and growing. The only pruning would be removing double leaders. The decision of which leader to save should be based on its vigor, erectness, number of internodal buds, and completeness of terminal buds. Weed and grass control is essential for good growth and survival. Herbicide application is the usual method.

The first summer's mortality should be replaced during the regular planting season with the same species originally planted. Replacement stock can be developed in a transplant bed where trees from the original planting stock are held. Sufficient trees should be ordered to meet this need.

2. **After Second Growing Season.** Same general instructions as for "After First Growing Season."

True firs develop slowly and are unlikely to require pruning at this time. When Atrazine is used to control grass and weeds, it should be applied between February 15 and March 30.

Mortality should be replaced with planting stock of the same species from a nursery or transplant bed. The planting stock should be large and thrifty to reduce the spread in tree sizes, and thus the cutting rotation. However, persistent mortality spots caused by shallow bedrock, sterile soil, or poor drainage should be either left unplanted or replanted to grand fir, Scotch pine, shore pine or some other more tolerant species. Replantings of true fir would likely die for the same reason that the original planting failed.

3. **After Third Growing Season.** Weed and grass control should continue. Most seedlings will not require pruning except for removing multiple leaders. A few exceptionally fast growers may have developed leaders longer than 12" to 16". These may be basal pruned to prevent excessive growth and to start a handle. However, in order to prevent overshock and stunting, not more than one half of the total live branches should normally be removed in any single year.

4. **After Fourth Growing Season and Thereafter Until Trees Are Harvested.** Weed and grass control should be continued. Basal prune only those trees that develop leaders longer than 12" to 16". Trees with leaders less than 12" long need their full crowns for adequate growth.

Annual leader growth of 12" to 16" is an acceptable length for true firs. Leader growth less than 12" will not detract from tree quality, but will unnecessarily lengthen the time required to develop merchantable size. Leaders longer than 16" or 17" will detract from tree quality and should be cut back during the late succulent stage to a single internodal bud. This bud is preferably one that is situated at least one inch above a cluster of internodal buds. At the same time, the lateral branches should be lightly sheared to form a uniform cone-shaped crown if the existing taper of the tree exceeds about 50%.

Shearing techniques for various true fir species are quite similar. However, grand fir may be sheared somewhat tighter than noble. Most growers strive for a grand fir shearing intensity about midway between that of Douglas-fir and noble fir. Shasta red fir are less apt to require shearing than noble fir. Their narrow self-shaping growth habit frequently makes shearing unnecessary.

L. CONCLUSIONS

True firs are in ever increasing demand for Christmas trees and bring top market prices. Attractive needles, heavy and symmetrical branches, and durable foliage are selling advantages. At the same time, true firs are considered the most difficult species to produce.

Relatively few Northwest growers have produced plantations of high quality true firs. The most successful growers have very carefully selected planting sites that are natually well-suited for growing true firs. These growers have also been selective about their seed sources. They have also cultured the trees very skillfully and intensively to attain desirable shape, density and spacing of whorls.

Until recent years, all true firs were developed with natural, unsheared crowns. This was very often wasteful production because many trees developed poor shape or excessively large openings between the whorls. Shearing is becoming increasingly popular to correct these defects and to increase the percentage of marketable quality trees that can be harvested from a true fir plantation. Growing numbers of consumers are beginning to accept, and even prefer, the more symmetric, dense, narrow crowns that are found on sheared trees.

M. PROTECTION

The following are recommended references:

Growing Christmas Trees in the Pacific Northwest, PNW-6, Cooperative Extension Service, Washington State University, Revision - May 1976.

Insect Control Guide for Commercial Christmas Tree Growing (Revised) Washington State University Extension Service, November 1974.

Pests and Disease Control Guide for Christmas Trees, C.S. Davis, E.E Gilden, C.S. Koehler and A.H. McCain, Pub. 2994, University of California Cooperative Extension Service, Division of Agricultural Sciences, Revision - January 1965.

Why Is My Evergreen Brown? A.D. Partridge and J.A. Schenk, Idaho Agricultural Extension Service Bulletin 514, 1976.

Wildlife Feeding Injuries on Conifers in the Pacific Northwest, William Laurence, Nelson B. Kverno, and Harry D. Hartwell, distributed by Western Forestry and Conservation Association, Portland, Oregon, 1978. $3.00.

N. HARVESTING AND MARKETING

Refer to the following bulletin: Christmas Tree Harvesting and Marketing for Pacific Northwest Growers, Bernard S. Douglass, U.S. Forest Service, Region 6, Portland, Oregon, 1979.

O. SOURCES OF ASSISTANCE AND INFORMATION

Most growers in Oregon and Washington belong to the Northwest Christmas Tree Association. Meetings, field tours, culturing demonstrations and current literature are provided for members. The name and address of the current secretary may be obtained by contacting any of the above mentioned sources of information.

Both the Oregon State and Washington State University Extension Services provide biennial two day, short courses for Christmas tree growers. Your local Extension Forestry Agent can provide information on time, place, and agenda of these training sessions.

Further information may be obtained from the Association Secretary.

The pesticides reported on and recommended here was registered for the use described at the time this manuscript was prepared. Since the registration of pesticides is under constant review by State and Federal authorities, a responsible State agency should be consulted as to the current status of this pesticide.

Pesticides used improperly can be injurious to man, animals and plants. Follow the directions and heed all precautions on the labels.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

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Developing Sheared Douglas-fir Christmas Trees

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CONTENTS

Page

A. INTRODUCTION 1

B. DEVELOPING A PLANTATION...... 1
  1. Site Selection..................... 1
  2. Recommended Seed Origins........ 2
  3. Planting......................... 3
  4. Grass and Weed Control........... 5
  5. Pre-shearing Care................. 7
  6. Basal Pruning.................... 8
  7. Shearing 8
  8. Year-by-Year Cultural Schedule from Planning.................14
  9. Planning the Next Crop...........16

C. DEVELOPING A NATURAL STAND..16
  1. Site Selection....................16
  2. Thinning and Hardwood Control....17
  3. Basal Pruning...................17
  4. Shearing.........................17
  5. Fertilizing with Nitrogen............18
  6. Planning for a Continuous Crop.....19

D. PROTECTION.....................20

E. HARVESTING.....................20

F. SOURCES OF ASSISTANCE & INFORMATION...............20

DEVELOPMENT OF SHEARED DOUGLAS-FIR CHRISTMAS TREES

A. INTRODUCTION

This publication describes the procedures for growing high quality sheared Douglas-fir Christmas trees in Oregon and Washington. It updates the previous edition, revised in June 1975, and includes new techniques developed since that date by growers, experimenters and scientists.

The purpose of shearing is to improve shape, taper and density of Christmas trees by cutting back the leaders and lateral branch tips. Shearing is always necessary to develop quality production on the faster tree-growing areas (Site III and better). It is also finding increased application, together with fertilizing, on slower tree-growing areas (Sites IV and V) that formerly produced only unsheared trees.

Prior to about 1960, virtually the entire cut of Douglas-fir was from unsheared stands on slow tree-growth areas (Sites IV and V). By 1978, sheared trees cut from plantations and natural areas accounted for approximately 70 percent of the total Douglas-fir cut. An estimated 90 percent of these sheared trees were developed in plantations and the remainder in natural stands. The trend toward sheared trees is sharply upward, as indicated in Table 1.

Table 1.— Sheared Douglas-fir Christmas Tree Production in Oregon and Washington, 1959-78

Year	Number of Trees Harvested			Percent
	Total	Sheared	Unsheared	Sheared
1959	3,040,000	30,000	3,010,000	1
1964	2,770,000	140,000	2,630,000	5
1969	2,420,000	532,000	1,888,000	22
1974	2,300,000	1,242,000	1,058,000	54
1978	3,500,000	2,450,000	1,050,000	70

Sheared Douglas-fir have been particularly well received in California and Arizona, which absorb about 60 percent of all Christmas trees produced in Oregon and Washington. They are increasingly in demand in other regions. Most promising markets appear to be in the Gulf and Atlantic seaboard states.

National Christmas tree statistics for 1977[1] credit Douglas-fir with 35 percent of total United States Christmas tree production, replacing Scotch pine as the leading Christmas tree species. Douglas-fir is the leading Christmas tree species in Oregon and Washington by a wide margin. It accounts for about 76 percent of the total 1978 harvest in both States.

B. DEVELOPING A PLANTATION

1. Site Selection

Plantations should be established on open, well-drained adequately fertile fields. Typically such fields are located on hill-land farms, upland benches or rolling lowlands formerly planted to agricultural crops such as grain, berries, hay and pasture. Lands rated only marginal for other agricultural crops may, with proper management, produce excellent sheared Douglas-fir Christmas trees.

High Site IV, Site III and Low Site II lands that produce a medium rate of tree-growth are usually better suited for sheared Douglas-fir than either extremely high or extremely low quality sites.

Low Site IV and Site V lands usually produce a shearing response which is too slow unless fertilizers are applied to stimulate tree growth. High Site II and Site I lands normally tend to produce for Christmas tree growers excessively rapid, unwieldy growth with heavy suckers and stubs after shearing. Fortunately, a large share of the marginal-type farmlands in western Oregon and western Washington are rated medium site. Your local county extension agent or Extension Forestry Agent or Soil Conservation Service Representative can help analyze prospective plantation areas for site classification as well as other characteristics that are important for producing high quality Douglas-fir Christmas trees.

Poorly drained fields should be avoided. Indicators of poor drainage are standing water during prolonged rainy periods or floods or presence of water tolerant plants such as wire grass, sedge, skunk cabbage, buttercup and wild parsnip.

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[1] National Christmas Tree Production and Harvesting Survey conducted jointly by the National Christmas Tree Association and U.S. Forest Service Northeastern Forest Experiment Station, 1978.

Frost pockets should also be avoided. Late spring freezing persistently occurs on certain areas and will damage or kill the tender new growth tips. Frost dieback lowers quality and, at the same time, prolongs the rotation. Frost pockets are frequently found in valley bottoms, natural bowls and extensive flat areas.

Highly productive bottomland agricultural soils are not generally the best choice for growing sheared Douglas-fir Christmas trees. They are expensive to purchase and are usually better suited for other intensively managed crops. Disadvantages of such fertile sites are lush growth of competing grass and weeds, excessive rodent populations and frequent association with poor air drainage and high water tables.

Preferred areas are gently sloping. Douglas-fir is a sunlight lover. Where sustained slopes are steeper than about 10 percent, west side Douglas-fir usually responds best on southerly and westerly exposures. Slopes steeper than about 10 percent are also capable of producing good trees but may cause erosion problems and higher equipment operating costs.

Avoid planting areas with heavy infestations of Canada thistle, blackberry, quack grass and other hard-to-control competing ground cover. Several years of costly chemical applications or prolonged cultivation may be required to eliminate these species in established Douglas-fir plantations. They are relatively easy to eradicate by spraying or cultivating before the field is planted with trees.

Extremely sandy soils deficient in organic matter may produce adequate tree growth but may require reduced application rates of fertilizers and herbicides due to soil porosity.

Avoid competition from larger trees. Shade and root competition causes weak branches and sparse needles, especially when the competing trees are within 100 feet south or west of the Christmas trees.

Consider adequate winter access and trespass control.

2. Recommended Seed Origins.

Forest geneticists have discovered significant inherited growth characteristic differences in Douglas-fir from various seed origins. These differences may affect both Christmas tree quality and number of years required to produce a marketable stand of trees.

West-side plantations, where most Douglas-fir Christmas trees are produced, should be planted only with seedlings from west side seed sources. East-side and Rocky mountain strains have excessively slow growth rates and tend to be susceptible to frost damage and needle cast diseases. Provenance tests have been made of numerous west-side seed sources to select the best strains. The Lake Cushman, Washington area and southeastern Vancouver Island sources were highly rated in western Washington and the Willamette Valley in Oregon.[2] For the Lake Cushman and Vancouver Island sources cones collected at 1,000 to 2,000 feet elevations produced better results than those collected near sea level. However, both low and medium elevation sources from the Willamette Valley appear to develop equally well.

Typical needle form of two highly rated seed sources, southeastern Vancouver Island (right) and Shelton, Washington (left) seed sources are compared.

Earliness of bud-bursting is an important consideration where frost or Douglas-fir needle midge damage occurs. Early bud-bursting strains such as southern and middle Willamette Valley and southeastern Vancouver Island are relatively susceptible to frost and midge damage. Later bud-bursting strains such as Lake Cushman, Washington are a better prospect where late frosts occur.

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[2] Bernard S. Douglass, U.S. Forest Service (Retired) and Gary H. Sander, Oregon State Extension Service, "Recommended Seed Origins for Douglas fir, Scotch Pine and Shore Pine Plantation Grown Christmas Trees in Western Oregon and Washington." October 14, 1966.

That portion of western Oregon, south of Roseburg, is probably best adapted to local seed sources which are acclimated to the generally warmer and drier sites found in this area. By the same token, it would be unsafe to use this seed source in the Willamette Valley or Puget Sound Basin.

A good general rule-of-thumb for west-side Christmas tree plantations is to select a seed origin not farther than 50 miles south or 150 miles north of the planting site. However if there is a chance that the plantation might go into timber production rather than Christmas trees, selection of a seed origin from the same tree seed zone and 500-foot elevation band is strongly recommended.

Although more than 95 percent of sheared Douglas-fir is normally produced west of the Cascade Summit, a few suitable sites also occur east of the Cascades. Examples are the higher site areas in northeastern Washington and mid-Columbia area near Hood River, Oregon, where annual leader growth exceeds about 14 inches. Another example is drier areas when irrigation can be used to improve survival and growth rate. Just as west-side seed sources are recommended for west-side plantations, east-side seed sources are recommended for east-side plantations. A Douglas-fir provenance test was established in the White Salmon, Washington area in 1972 to determine the best seed sources for mid-Columbia conditions east of the Cascade Summit. The Leavenworth, Washington strain rated highest overall in this test. It produced rapid growth and bright green needles similar to west side types. The Coconino strain from New Mexico was the best of several Rocky Mountain strains tested.[1] It produced moderately slow growth, narrow crowns and bluish needles typical of southern Rocky Mountain strains. West-side strains lack inherited resistance to the climatic extremes of heat, cold and dryness typical of east-side sites.

A relatively new development is collecting seed from individual parent trees which have proven by progeny testing to consistently produce genetically superior Christmas tree offspring. Seed orchards of these superior parent trees are likely to provide a growing share of future Christmas tree seedlings.

3. Planting

Ground Preparation — Newly planted trees show poor survival and growth if there is excessive grass or weed competition. Grass and weeds are detrimental in four ways: They rob moisture and nutrients from the soil; they shade and suppress the seedlings; they create a fire hazard; and they provide a habitat for mice, rabbits, gophers, root weevils and other tree-eating pests.

Fields should be deeply plowed, disked and harrowed before planting. Old fields and pastures with heavy sod also require summer fallowing to break down the sod. Some fields contain a heavy growth of Canada thistle, bracken fern, trailing blackberry or other hard-to-kill atrazine-resistant species. These may need to be controlled prior to planting by repeated cultivation or with selective herbicides. Some fields contain a hard, root-resistant plow pan or hardpan layer just below the normal plowing depth. In this case, a subsoiler or extra deep plowing greatly benefits root penetration and tree growth by breaking up the hard layer.

This field is being fall-cultivated in preparation for spring planting. A final disking and harrowing is recommended just prior to planting.

Quack grass is a special problem in some fields. Deep plowing is not recommended because it does not kill the roots, but only buries them too deep for easy eradication. A better solution is prespraying the field with one of several available effective quackgrass eradicating herbicides.

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[1] Richard Adlard, County Extension Agent, Stevenson, Washington, "Provenance Study of Promising Christmas Tree Strains for the Mid-Columbia Area," 3rd Annual Report, November, 1974.

Plantation Design and Layout — Recommended spacing is 5½-by-5½feet for developing trees 6½ to 7½ feet tall, which are the most popular sizes. This spacing provides about 1,300 trees per acre after deducting 10 percent of the full stocking for an adequate road system. Spacing may be adjusted somewhat if unusually narrow, wide, short, or tall trees are desired. For example, some growers space trees 3 feet apart in rows that are 5 to 5½ feet apart. Harvesting alternate trees within the rows for table top sizes provides adequate space for developing the remaining trees to 6-foot and larger sizes.

Planting in perfect squares (check rows) has the advantage of permitting mowing or cultivating in two directions and provides a more pleasing appearance than random spacing within each row.

TABLE 2.

Spacing in Feet	TREES PER ACRE	
	Planted Solid	10% Reduction for Roads
4½ ' x 4½ '	2,151	1,936
5 ' x 5 '	1,742	1,568
5½ ' x 5½ '	1,440	1,296
6 ' x 6 '	1,210	1,089
6½ ' x 6½ '	1,031	928

To make check rows, score the ground lightly in two directions before planting to mark out a square grid as a guide, or plant along a wire marked at desired intervals. However, many growers do not believe that the added time and cost of planting in check rows is justified. They prefer, instead, to machine plant the trees randomly in straight rows and rely on chemicals to control grass and weeds.

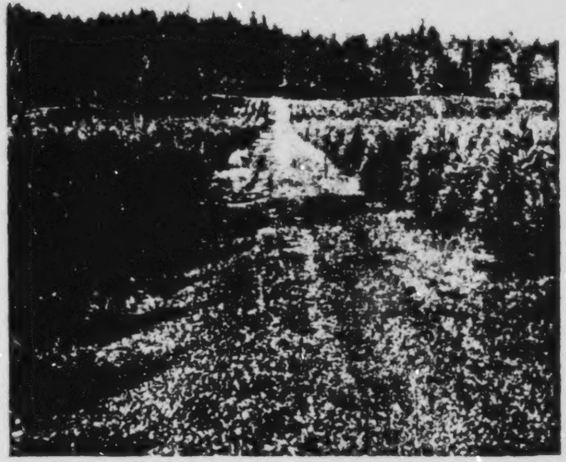
Unless the size of the operation and the availability of services would justify helicopter yarding, roadways are needed through the plantations to provide access. These can be provided by skipping the planting of three adjacent rows at intervals of every 30 to 50 rows.

Weed and grass-free firebreaks are also recommended around flammable perimeters of the plantation, particularly next to public roads.

Correcting Nutritional Deficiencies Prior to Planting — Plantation managers should have knowledge of nutritional levels of their soil before planting Douglas-fir Christmas trees. Minimum levels of principal nutriments (nitrogen, phosphorus, potash, calcium, magnesium and sulphur) are necessary for good growth. For example, shortage of potassium causes winter yellowing and in extreme cases, needle drop and bud aborting in the lower crown. Shortage of nitrogen causes stunted growth and also yellowing of the needles. Deficiencies are most likely to occur in fields where continuous past farming has consumed available nutriments with no provision for replacement.

It will pay most growers to have a soil analysis made to determine the types and quantities of additives that should be worked into the soil before planting. Instructions on soil analysis procedures may be obtained from your Extension Agent. Be sure to include a statement with the soil samples that the intended use of the land is for growing Douglas-fir Christmas trees.

Planting Stock — Seedlings from a number of identified seed sources may be purchased from the Mike Webster Forest Nursery, Washington State Department of Natural Resources, Olympia, Washington. They may also be purchased from several private tree nurseries which specialize in Christmas tree stock. Extension Agents can provide additional information on nurseries and tree ordering procedures.



Well-planned access roads facilitate culturing and harvesting operations. They also serve as firebreaks.

Planting stock should be ordered well in advance of planting and arrangements made for delivery or pickup just prior to planting. Seedlings are packed in waterproof bags or boxes at the nursery and stored in cold rooms prior to pick-up or shipping. If trees are not planted within about 1 week after delivery, they should be stored in a 35° F. cooler or heeled in where there is protection from root drying, direct sunlight and drying winds. Temporary storage should be outdoors in a cool (but not freezing) shaded spot.

Some growers have improved survival and growth rate by purchasing 1-1 or 2-1 transplant stock which have developed 1 or 2 years in the nursery bed and an additional year in a transplant bed. Transplants can also be developed at home from regular 2-year-old seedlings.

Planting Techniques — Adequate survival requires skillful planting techniques. Early spring planting (February, March, April) is usually more successful than fall planting, especially on heavy soils that are subject to frost heaving. Soils should be sufficiently dry at the time of planting to be loose and crumbly, the same as for planting a garden.

Best growth and survival is experienced where trees are planted as soon after February 1 as favorable soil moisture conditions will permit.

Small acreages are usually planted by hand, using a power auger, shovel or planting bar. One man can plant about 400 to 800 trees per day. However, time and money may be saved by planting larger areas with a tractor-drawn tree planting machine. A single-row planting machine can plant 5,000 to 10,000 trees per day. Excellent survival can be achieved when good equipment is properly operated on well-prepared ground.

Machine planters cut deep channels into the soil. This often starts gullying on steep slopes. Erosion can be reduced by planting along the contours, rather than up and down the slopes.

Loss of planted trees is greatest during the first year. Survival of up to 99 percent has been experienced under very favorable conditions. On the other hand, survival of less than 50 percent may occur under unfavorable conditions. Retaining some of the seedlings of the same seed source in a transplant bed will provide a handy source of planting stock to replace dead trees during the first year or two after establishment of the plantation.

4. Grass and Weed Control.

Chemicals — Effective grass and weed control is the greatest single key to good survival and growth of planted seedlings. Shallow cultivation was, until the early 1960s, the only method of eliminating grass and weed competition. Today it has been largely replaced by spraying the ground with chemical grass and weed killers known as "herbicides." Atrazine has been the most effective general herbicide known at this time for Northwest conditions. Atrazine can be applied over the tops of dormant trees without damaging neeedles or roots. Moreover, it is effective as either a *post-emergent spray* on existing grass and weeds or as a *pre-emergent spray* to prevent future growth on most grass and weed species on clean cultivated areas. Atrazine breaks down chemically in the soil and must be reapplied every year. Instructions for using atrazine follow:

Atrazine treated plantation (left) is compared with untreated area (right).

Season to Apply — Best results from both pre-emergent and post-emergent spraying are obtained from mid-February through March. However, fair results may be obtained for pre-emergent spraying as late as April on newly planted areas. At least 2 or 3 inches of rainfall are desirable between the time of application and the beginning of the growing season.

Mixing Instructions — Atrazine is a wetable powder which is mixed with water in the spray tanks. Mechanical or by-pass agitators in the spray tanks are necessary to prevent the atrazine from settling out. As little as 1 gallon of water per pound of atrazine may be used for aerial applications, while 10 or more gallons of water per pound are recommended for spraying with ground equipment.

Pre-emergent Spraying — The purpose of pre-emergent spraying is to prevent sprouting of grass and weeds on bare ground. This is the most effective way to use atrazine. It should be broadcast-applied directly over the tops of newly planted seedlings. Some experienced growers wait until one heavy rainfall after planting before broadcast spraying with an herbicide. Rain tends to compact the soil and wash it into air cavities around the roots, thus reducing the risk of leaching toxic chemicals into the root area. Tractor-operated boom spraying or aerial spraying methods are feasible. Usual application rates are 4 pounds per acre on sandy soils, 5 pounds per acre on average soils and 6 pounds per acre on soils with a high content of organic matter. A spreader-sticker added to the spray will improve its effectiveness. Plantations usually require respraying every year in February or March for good grass and weed control. However, the application rate of atrazine is sometimes cut down to about 3 or 4 pounds per acre where past applications have eliminated most of the competing vegetation.

Post-emergent Spraying — The purpose of post-emergent spraying is to kill existing grass and weeds in established plantations. Small trees may be either aerial or boom sprayed, but larger trees require aerial application or narrow-gauge equipment that will work between the rows to avoid mechanical damage to trees.

Some growers have developed their own narrow-gauge spray equipment to operate between tree rows. These contain a number of low-profile spray jets to give coverage between and under the trees. Application rates of 4 to 6 pounds of atrazine per acre are adequate for controlling many grass and weed species. Up to double this amount may be required to control particularly atrazine-resistant species such as quack grass. Certain weeds such as bracken fern, blackberries, false dandelion and Canada thistle are resistant to atrazine. These species should be controlled with a carefully directed spray of other chemicals.

A 3-gallon sprinkling can may be used to do a satisfactory spray job on smaller plantations or home transplant beds that won't justify purchase of hiring of spray equipment. Instructions for this procedure follow:

Thoroughly mix 1 tablespoon of atrazine per gallon of water in the sprinkling can. Normal tipping of the can during use will keep the atrazine in suspension. Three gallons will cover approximately 300 square feet of ground or provide a 3-foot diameter circle around about 40 individual trees.

Atrazine is available in granule, powder or liquid form. The granule form "Nine-O" can probably be recommended over the other types for general use. Nine-O is more concentrated (90% active) and denser, so it takes less space in storage and goes farther in the field. To treat 100 acres at the medium rate, one handles and mixes just 260 pounds of Nine-O, compared to 550 pounds of Atrazine liquid or 300 pounds of Atrazine powder. Follow the label for mixing instructions.

Other chemicals being used by the Christmas tree growers include Velpar, Roundup, Kerb and Asulox. Velpar may supplement Atrazine as a general all-around grass and weed killer. Damage by Velpar has been noted in some Douglas-fir plantations under 2 years old. The suggestion is for growers to limit their first use to small areas. Rates, for the control of annual weeds, normally mean using Velpar at 1½ pounds per acre. For the control of perennial grasses (orchard grass, quackgrass, tall fescue, etc.) use Velpar at 2 to 3 pounds per acre. Rates below 2 pounds per acre will not satisfactorily control perennial grasses. Certain fine-textured clay soil types high in organic matter may require 3 pounds per acre for perennial grasses. Velpar requires good agitation. Check label for mix instructions. Velpar can be applied about the same time as Atrazine.

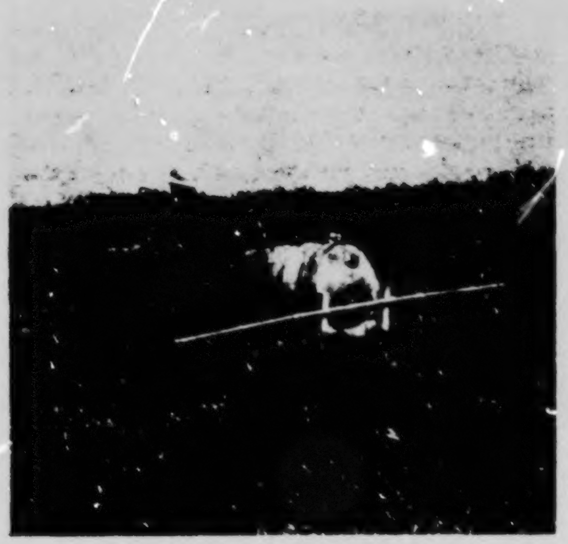
Roundup, as the name implies, will kill a wide variety of grasses and weeds. It should be used as a directed spray, using 2 to 3 oz. per gallon of water. It is applied to plants when they are actively growing. Roundup controls Canada thistle.

Kerb will do a top notch job in controlling grass. It will not kill weeds. It should be applied late fall or early winter. Kerb has a relatively low water solubility. Use as a broadcast spray.

Asulox is used in the control of bracken fern. Spray at the rate of 1 gallon per acre. Spray when fern fronds are fully developed and after July 15th. Some damage has been noted on Douglas-fir when Asulox was applied during the early growing period.

For control of trailing blackberry, use Roundup or Amino triazole at the rate of 2 pounds of each chemical per 100 gallons of water. Spray in July-August. Expected control is rated as good. Himalaya and Evergreen blackberry can be controlled also in July-August using Roundup or Aminotriasole at 4 pounds (2 gallons) per 100 gallons of water. Results should be good to excellent. To control scotch broom use 2 pounds 2,4-D in 5 to 10 gallons of water per acre. Results should also be excellent.

To prevent the buildup of possibly phytotoxic chemicals in Christmas tree plantations always limit chemical applications to the lowest effective quantities. It is also wise to rotate chemicals periodically rather than using the same chemical over the same ground year-after-year.



Sprayers can be inexpensive and still be effective.

Cultivating — Although largely replaced by chemicals, cultivation still has a place for grass and weed control. Conventional tractors and cultivators may be used when trees are small enough for the tractor to straddle their tops without causing damage. Larger trees require narrow-gauge, shallow-digging, rotary types that can be operated between the rows. Situations that favor cultivation include:

a. Controlling chemical-resistant grass and wood species.

b. Mulching compacted, cracked, clay-type soils to conserve moisture.

Mowing — Unlike cultivation or chemicals which are intended to kill competing vegetation, mowing merely controls the height of such vegetation. Like cultivation or chemicals, it benefits the trees by eliminating shade on the lower branches, preventing entwined blackberry vines and other vegetation in the lower crowns, conserving soil moisture, reducing fire hazard and removing the rodent habitat. It also facilitates moving about between the rows and working around the bases of the trees during such cultural operations as shearing, basal pruning and spraying. Mowing is sometimes actually preferred to bare ground conditions during the last few years before harvesting where a low vegetative cover is desired to control erosion or to prevent muddy harvesting conditions.

Narrow, low-profile rotary or hammer-type mowers are recommended. They shred grass and weeds into small particles, thus reducing their fire hazard and hastening their decay. However, sickle bar mowers may be necessary to cut extremely heavy grass or weeds that rotary types won't handle.

5. Pre-Shearing Care

The grower's main concern during the first year or two after planting is to keep his trees alive, healthy and growing rapidly. Grass and weed control has been described. The following additional jobs are also necessary:

a. Protect the seedlings from damage by fire, deer, livestock and rodents. Fire trails, mowing, fencing or baiting may be necessary.

b. Replace dead, sickly or genetically inferior seedlings with healthy stock. Most growers stop replanting after the second year to prevent an uneven-aged stand. However, some growers continue replacing dead trees for another year or two and develop table-sized trees from later replacements by means of early, tight shearing.

Multiple leaders should be cut flush with the stem as soon as they appear.

c. Remove all multiple leaders except one by cutting them flush with the main stem. The single retained leader should be selected on a basis of size, vigor, straightness and number of buds.

d. If the terminal bud dies or a leader is broken off at its base, a new leader will likely develop from a turned-up branch of the top whorl. However, multiple leaders tend to develop in this case. This can be corrected by cutting back the tips of all the branches in the top whorl except the one selected to form a new leader.

e. Occasionally an entire tree will suffer major damage from freezing, heavy grazing, vandalism or equipment. Young Douglas-firs have a remarkable ability to recover from such damage if more than about 20 percent of their original live branches survive. The established root systems enable the damaged trees to form new sprouts. These will often produce a Christmas tree quicker than a replanted seedling.

6. Basal Pruning

Basal pruning is one of the standard practices to develop high quality sheared Douglas-fir. It consists of removing unwanted lower branches between the bottom of the Christmas tree and the ground. It should form a reasonably straight handle of at least 1 inch per foot of tree height. Basal pruning should be sufficiently high to avoid serious defects such as incomplete bottom whorls and crooked handles. The branches should be cut flush with the stem to avoid both stubs and heavy scars. A hand pruner is the most common basal pruning tool used when trees are young and small-branched. Older, large-branched trees may require use of a saw or a short, heavy machete. The selected bottom whorl should contain five or more well-distributed, vigorous branches. Ideally it should be located 10 to 12 inches above the ground in well-cared-for plantations where grass and weeds are effectively controlled by chemicals, cultivation or mowing. Where grass and weeds are not effectively controlled, the bottom whorl should be located above the level of heavy shade.

A cluster, or rosette, of internodal branches, as well as a main branch whorl, can be used to develop an acceptable bottom whorl on a plantation-grown Douglas-fir. In practice, internodal branches are more frequently chosen for the bottom whorl than a natural node. This may save a year's growing time over selecting a main branch whorl higher on the stem. Other advantages of forming a shorter handle are keeping the crown low for easy reach in shearing and providing sufficient shade to inhibit growth of adventitious sprouts on the handle. The proper year to start basal pruning is important. If done when the tree is too small, it may cause shock and appreciably stunt next year's growth[4]. If postponed too long, it may require the cutting of heavy, dense branches and raise pruning costs. Basal pruning too late may also allow insufficient time for the handle to heal over smoothly and the bottom whorl branches to overcome a suppressed appearance on their undersides.

A happy medium would be to defer basal pruning until the tree has attained sufficient size that pruned limbs will not exceed about one third of the total foliage. For most trees on medium growth plantations (Site III), this stage of development occurs after the third growing season when the trees are about 3½ to 4½ feet tall. Lower site plantations would normally be basal pruned 1 year later or the year after shearing is begun.

7. Shearing

Shearing involves cutting back leaders and lateral branches to perfect the cone shape, control the percent taper (width of a tree expressed as a percentage of its height), and increase the density. Douglas-fir responds better to shearing than any other fir species grown in the Pacific Northwest.

This tree is receiving its first shearing. Basal pruning will be deferred one more year to prevent overshock.

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[4] Bernard S. Douglass, U.S. Forest Service, in cooperation with the Oregon and Washington Extension Service, Oregon State Department of Forestry and Washington State Department of Natural Resources, "Leader Growth Control Studies for Douglas-fir Christmas Trees," April 1, 1964.

Unnecessarily high basal pruning prolongs the rotation period required to grow marketable sheared trees. It also makes shearing more difficult.

Year to Start Side Shearing — Most trees in medium site plantations will be sufficiently developed to start shearing after three growing seasons. In order to be ready for its first side-shearing, a tree should meet the following qualifications:

a. More than about 5 feet tall.

b. More than 50 percent taper (crown width more than half its height). Shearing should be deferred at least one year for any trees too short or too narrow to meet these requirements. The sooner that a tree is ready to shear, the sooner it will be ready to harvest. Therefore, it will pay a grower to do everything possible to encourage fast, early uniform growth of his plantation. Some of the procedures that will encourage rapid tree development follow:

(1) Choose a plantation site that is well-suited for Douglas-fir.

(2) Fertilize if nutritional levels are inadequate.

(3) Cultivate deeply and intensively in preparation for planting.

(4) Select a seed origin that is adapted to the site and well-suited for growing fast-developing Christmas trees.

(5) Plant healthy, husky, uniform-sized seedlings.

(6) Practice intensive grass and weed control throughout the rotation.

Year to Start Leader Shearing — The proper year to begin leader pruning is determined by the height of a tree, not its age. Some trees are likely to be ready to start leader pruning the same year that side shearing is begun. However, most trees will not be ready until the following year. For developing the popular 6½- to 7½-foot tall trees, a good rule-of-thumb is to defer leader pruning until total tree height first exceeds about 4½ to 5 feet. Then as a part of the shearing operation, cut the leader back sufficiently to reduce the tree height to about 4½ to 5 feet. Trees with exceptionally numerous leader buds can be pruned as much as 6 inches taller than this recommended height range, but those with sparse buds should be pruned back a like amount shorter than 4½ to 5 feet.

If either taller or shorter trees than 6½- to 7½-foot average are desired, a corresponding increase or decrease in sheared tree height after the first year's leader shearing should be planned. After the first year's leader pruning, an annual pruned leader length of about 12 inches should be maintained each year until harvest.

Time of Year — Douglas-fir has a long shearing season. It begins in the middle of July when the branches are fully elongated and buds on the new growth become visible, and extends in the following spring until the buds start to open. Shearing too early in the season sometimes stumulates late summer regrowth sprouts, called *lammas growth,* especially when summer rains occur. Resulting irregular, excessively long branch tips may require touching up to restore good proportion during the year of harvest.

An exception to the long shearing season is the final shearing before harvest. For this, July 15 to October 15 is the preferred period. Late summer or early fall shearing allows sufficient time for the sheared stubs to callous over and the sheared branches to assume a more natural appearance before the harvesting.

Tools — Shearing knives, hedge shears and power clippers are effective shearing tools. Any of these tools in experienced hands will produce professional quality shearing.

Knife shearing is presently the most popular method. It is accomplished by long, sweeping downstrokes with a thin, sharp knife 14 to 18 inches long. Leg protectors are strongly advised for safety when using knives. Another safety measure is leaving two rows of trees between personnel in the shearing crew. Right-handed shearers should work counter-clockwise around each tree to keep their left leg clear of the knife strokes. Left-handed shearers should work clockwise.

Hedge shears are usually held upside-down to make the angle of the blades conform with the contour of the tree. The tree is clipped from the top downward using a series of quick strokes. Hedge shears are not as efficient as shearing knives, but are safer to use and provide less strain on the operator.

Many growers pre-shear the leader and top whorl with a hand pruner as a separate operation from side shearing. This permits better control in correcting defective tops and in cutting individual branches to exact desired lengths.

Lightweight clippers powered by electric or gasoline motors are used to an increasing extent for shearing. Both rotary knife and sickle-bar types are available. They will likely come into much greater future use with technological improvements and the current trend toward mechanization.

Every person should carry a hand pruner while shearing. This is the most effective tool to cut back leaders and top whorls. They are also handy for removing suckers and multiple leaders, trimming top whorls and leaders and correcting in-pointing branches and other defects.

Techniques — Some growers pre-shear the leaders and top whorls with a hand pruner as a separate operation from the side shearing. Others do both jobs as a single operation. Basic techniques are the same either way. Cut the leader back at a point about 1½ inches above a lone internodal bud, which will form next year's leader. The purpose of leaving this 1½-inch stub on the top of the pruned leader is to prevent die-back of the top bud, provide a bird perch to reduce break of the top bud and a tying post to straighten the new leader if it does not grow erect. The top bud forms next year's leader and the internodal buds below it develop into lateral branches.

A shearer is expertly knife-shaping trees in a 3-year-old plantation. He strives for a narrow, uniform cone-shape between the sheared leader and bottom whorl.

The pruned length of the leader will depend on the height of the tree. As mentioned earlier, the first leader pruning will leave a stub of intermediate length to obtain a sheared tree height of 4½ to 5 feet. Thereafter, until harvest the leader should be shortened each year to about 12 inches. However, its exact pruned length during the year of harvest can be adjusted somewhat to make it conform aesthetically with the overall height and taper of the crown.

At the same time the leader is pruned, the tips of the lateral branches of the top whorl must be pruned back to restore good proportion and prevent them from turning up to form multiple leaders. The top whorl should be left sufficiently long to contain at least four buds on each branch. Ideally, the cut should be made just above an internodal bud on the lower side of the branch or two opposite side buds. Any bud occurring on the top side of a sheared branch tip should be picked off to prevent its forming an unsightly in-pointing branch.

The following technique for pruning the top of the tree will help attain best possible crown shape: cut the leader and top lateral branches very carefully and skillfully with a hand pruner. Try to make this top portion of the crown resemble a miniature, symmetrical, cone-shaped Christmas tree. This will form a guide or starting point, for the side shearing.

After pruning the leader and top whorl the tree is ready for side shearing. The objective is to extend the taper downward in a straight line to the bottom whorl and form a uniform, near-perfect cone shape. Percent taper means the width of the crown expressed as a percentage of its height. Taper should be quite narrow (about 50 percent) for intermediate shearings and increased to about 60 percent for the final shearing before harvest. This final widening permits light, skillful finish-shearing. Resulting appearance is natural and free of heavy stubs.

Once started, shearing must be continued each year until the tree is harvested. After three or four shearings, trees lose their appearance of having distinct whorls because the stimulated growth of internodal branches fills in the internodal spaces.

Correcting Multiple Tops on Sheared Trees—The larger and more vigorous the tree, the more multiple leaders and suckers it produces and more complicated the leader pruning job becomes. The first leader pruning is a simple operation because it merely shortens a single, natural leader. The second leader pruning, too, is seldom complicated. But the third and fourth leader prunings may involve problems and difficult choices where several multiple leaders and perhaps, also, some heavy suckers have formed. A few helpful hints for correcting these problems follow:

A tree with two or more erect leaders should be pruned to leave **only one** centrally located, upright leader. The best one to save is normally the **lowest** one on the stem. **Completely** removing its competitors higher on the stem prevents short, heavy, upright stubs. It also gives the top of the tree a more compact appearance.

Suckers sometimes form from unsheared internodal branches below the main leader. They are sometimes more vigorous than the true leaders. Merely shortening their tips, instead of completely removing them, forms heavy unattractive stubs. In some instances, a sucker may be more upright and centrally located than the true leader. In this case, the true leader may be cut off and the sucker used for a substitute. But in most cases a better appearance and greater tree height can be realized by removing the entire terminal growth of the sucker just above its first branch forks by "fork shearing."

Preventing Multiple Leaders—Multiple leaders cannot be entirely eliminated on vigorous sheared Douglas-firs. They can be minimized.

One method is to leave a gap of an inch or two between a lone top bud on the sheared leader and an internodal cluster of buds below it. The growth energy will tend to concentrate in the top bud, and the internodal bud cluster will usually form a false whorl. Needless to say, if a bird breaks off the top bud during its succulent stage of growth, this technique will fail and corrective work for multiple leaders must be anticipated.

A second method to reduce multiple leaders is to cut the leader during its late succulent stage about July 1. The retained internodal bud near the top of the leader stub will gradually develop a more upright position during the course of the growing season. This encourages more upright growth of the new leader and improves its resistance to bird and wind breakage during its succulent stage. However, most growers find it difficult to accomplish all their shearing during the short succulent season and, instead, rely on correcting multiple leaders and "dog-legs" after they have formed.

A third method is to shear all the top portion of the tree, except the desired leader during the late succulent stage in July. This encourages dominance and upright growth of the single retained leader. It should be shortened to about 12 inches once it has assumed a normal vertical form later in the summer.

Leader Straightening — Next year's leader, arising from the top bud of a pruned leader, does not always grow straight and erect. It may have a noticeable offset, called a "dog-leg," where the top bud turns upward to form a new leader. This condition should not cause alarm prior to the harvest year because bent or crooked leaders usually tend to either straighten themselves or become hidden by new growth. However, they may cause noticeable top defects on trees ready for harvest unless corrective action is taken at the time the trees receive their final or "finish" shearing. A simple but effective method for correcting a typical dog-legged leader is to bind it tightly against a 2-inch long leader stub left for this purpose. A couple of wraps with a plastic ribbon is useful for tying the leader in an upright position against the stub. Sometimes a dog-legged leader is too rigid and coarse to straighten. In this case, it should be cut off and a flexible internodal branch below it tied to a vertical position by the same method. This procedure may also be used for replacing a leader too high on the tree for good proportion and density, or for replacing a leader broken by birds or wind during its succulent stage of growth.

Replacing Undesirable Leaders — Some trees develop unusually coarse and vigorous leader growth a year or two before they attain harvest size. Such leaders are sometimes abnormally large in diameter and very sparsely budded for a foot or more above their bases. Cutting them back in the usual manner to a 12-inch stub results in too few buds to fill in the top of the tree with branches. This scarcity of buds causes an open "hole" in the upper crown of the tree. Another serious problem is that the few buds that do occur on this heavy leader stub absorb too much of growth energy and develop into large, coarse, dog-legged multiple leaders called "deerhorns." This problem, once it starts, tends to perpetuate itself each year until it is corrected.

The deerhorn problem can be corrected by completely removing the large leaders that form the deerhorn. Then a flexible internodal branch about 2 inches below the point of cut is bent upward and bound firmly against the 2-inch stub with two or three tight wraps of plastic ribbon. Lastly, the upturned internodal branch is cut back to proper length, about 12 inches to form a new leader. Unlike the natural deerhorn leader, it is usually well-budded and sufficiently small not to form abnormal top growth during the following growing season. Cutting back the large natural leader actually enhances the development of the tree by directing growth energy into the lower portion of the crown. The stub and plastic ribbon should be removed after the tied leader has become set in a vertical position.

Comparative Shearing Experiments — Two formal shearing studies were initiated in Oregon and Washington to evaluate and compare various sheared leader length combinations. The objective of the experiments was to determine which shearing technique would develop high quality 6- to 8-foot trees in the shortest possible growing time and with the least possible expenditure for labor.

The first experiments were conducted in 1964-1969 on two medium growth rate plantations; one near Corvallis Oregon and the other near Olympia, Washington. Both areas were considered well adapted for production of sheared Douglas-firs. One of the methods which we call the 20- to 16-inch to 12-inch method of progressive leader shortening, produced higher quality over a shorter rotation than any of the other methods tried at that time.

Procedures for applying it follow:

a. Defer leader pruning until leader length first exceeds 20 inches. Then prune the leader back to approximately 20 inches long. Every year thereafter, shorten the leader by about 4 inches to a minimum leader stub length of about 12 inches. Thus, the leader is progressively shortened each year from 20 inches the first year, to 16 inches the third year, and to 12 inches every year thereafter until the tree is ready to harvest.

b. Start side shearing to form a cone with a 50 percent taper when the height of a tree exceeds about 4 feet and its taper exceeds 50 percent. Shear to a 50 percent taper each year thereafter until the year of harvest. Then widen the taper to 60 percent to reduce visible stubs and impart a more natural appearance.

c. Avoid over-shocking the tree by deferring basal pruning until the crown is sufficently developed so that not more than one-third of the foliage will be removed. Most trees are ready to basal prune after three growing seasons.

The second shearing experiment was conducted near Molalla, Oregon in 1970-74.[3] Its purpose was to explore several new progressive leader shortening techniques and to compare them with the 20″-16″-12″ method. The most successful of these, which we call the "5-foot method" produced 6½- to 7½-foot tall trees of equivalent quality and over the same rotation as the 20″-16″-12″ method. We recommend using the 5′ method because it is simpler to apply and results in a more uniform height development of the stand. Procedures for applying it follow:

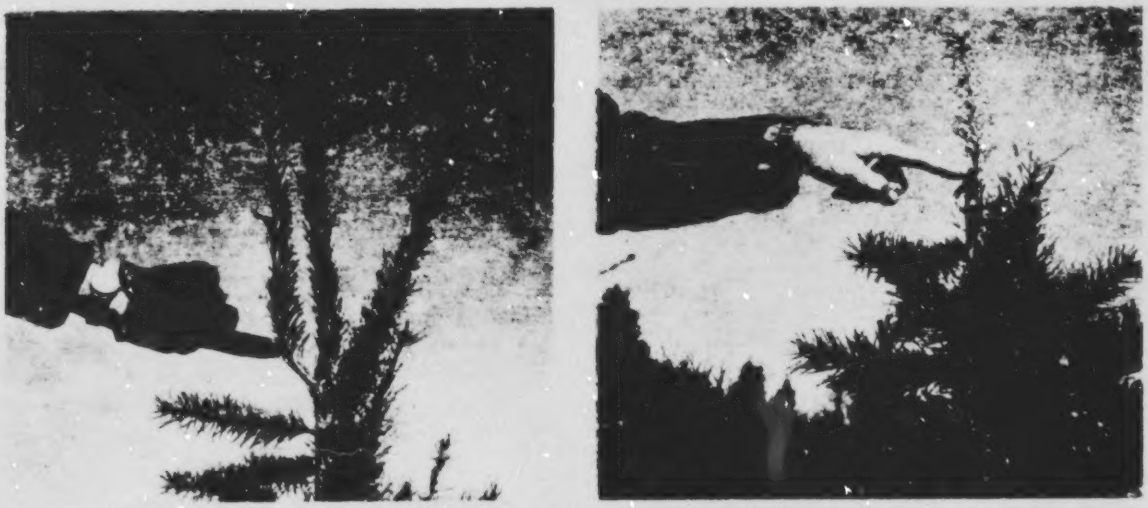
a. Defer leader pruning until tree height first exceeds 5 feet. Then prune the leader back sufficiently to reduce the sheared height of the tree to about 5 feet. Every year thereafter until harvest, prune the leader back to approximately 12 inches. If an average harvestable tree height taller or shorter than 6½ to 7½ feet is desired, simply increase or decrease the sheared height of the tree after its first leader pruning a corresponding amount. If, for example, 6- to 7-foot harvestable tree heights are desired, the first leader pruning should reduce height of the average tree to 4½ feet instead of 5 feet.

b. Side shear and basal prune the same as described for the 20″-16″-12″ method. The principle of both the 20″-16″-12″ and 5′ methods of progressive leader shearing is to maintain relatively wide internodal spacing near the base of the crown where several years of growth can be anticipated to fill in the open spaces. At the same time, progressively shorter spacing is maintained toward the top of the crown to develop uniform density from top to bottom.

Although both methods usually produce about the same quality 6½- to 7½-foot trees in the same growing period, we find that the 5′ method has several advantages.

It is relatively simple to apply and explain to inexperienced shearing crews. The average worker has little difficulty in cutting back the height of a tree to his nose height, for example, and then cutting the leader to an approximate 12-inch stub during subsequent shearing. However, he might be greatly confused by a complicated leader shearing schedule that calls for a different pruned leader length every year.

Another advantage of the 5′ system is its workability on either fast or slow growing sites. If leader growth on Site IV land, for example, is incapable of growing 20 inches, it is obvious that the 20″-16″-12″ method of leader pruning cannot be used.



The picture on the left shows coarse sparsely-budded multiple leaders known as "deerhorns." These need correcting to prevent future openings and deformities in the top portion of the crown. The picture on the right shows the same tree after corrective top shearing with a hand pruner. Note that the harp-shaped multiple top was pruned off just below the fork, together with the two internodal branches nearest to the fork. Pointed out is where an internodal branch was tied vertically against the leader stub to form a new leader.

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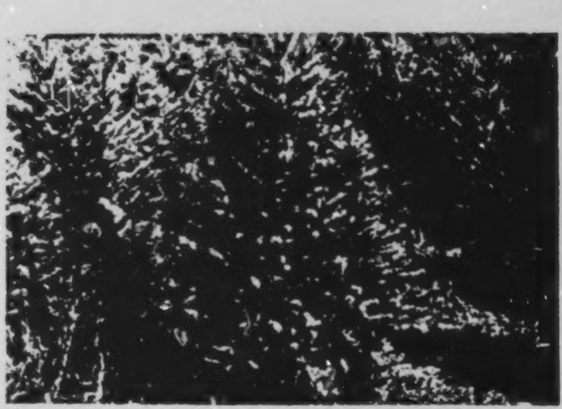
[3] Bernard S. Douglass, U.S. Forest Service, in cooperation with the Oregon and Washington Cooperative Extension Service, Oregon State Department of Forestry, Washington State Department of Natural Resources, Northwest Christmas Tree Association, J. Hofert Company and Holiday Tree Farms, "Progress Rep. on Field Comparisons of Various Shearing Methods to Develop Douglas-fir Christmas Trees," 1968.



This beautiful stand of sheared Douglas-fir was produced in only 5 growing seasons by the progressive leader shortening method of shearing. About one-third of the trees are now ready to cut. The remainder will be harvested in the next 2 years.

A final advantage is greater uniformity of stand height at time of harvest. A 20-inch plus leader can develop at various height levels on individual trees. These would cause corresponding tree height differences at time of harvest.

8. Year-by-Year Cultural Schedule from Planting Until Harvest.

After the First and Second Growing Seasons — During the first 2 years, concentrate mainly on keeping the trees alive and vigorous.

The only required pruning would be removing multiple leaders and suckers. Select the best of the multiple leaders on a basis of vigor, erectness and bud set. Cut all others flush with the main stem.

Replace any dead trees during the next regular planting season. Replacements made after this year would be unlikely to catch up with the other trees in time for harvest.

Grass and Weed Control — Atrazine or other selective sprays applied immediately after planting will usually remain effective through the first summer. Reapply chemical sprays during the following February 15 to March 30.

Cultivating is usually unnecessary with chemical sprays. Exceptions might be to retain moisture in heavy, cracked clay soils or to control a heavy cover of atrazine-resistant grass and weed species. However, a more successful way to control atrazine-resistant grass and weeds is to kill them with a directed spray before they get out of control. Particularly troublesome species include trailing blackberry, Canada thistle, bracken fern and orchard grass. It is important to control those species as quickly as possible to reduce competition to the trees and prevent them from spreading.

After the Third Growing Season — Some of the fastest growing trees might attain heights of more than 4½ to 5 feet. These are now ready for their first leader pruning. Cut the leader back sufficiently to form a 4½- to 5-foot tree. At the same time, shear the side branches to form a near perfect 50 percent cone between the sheared top of the leader and the bottom whorl of branches.

Trees 4½ to 5 feet should be side sheared to form a cone-shaped crown with a 50 percent taper. In-pointing branches, suckers and other defects should be removed at the time of each shearing.

Basal prune to form a clean handle when this will not remove more than about one-third of the total foliage.

Continue broadcast and spot spraying to control grass and weeds. Aerial application is the usual broadcast method when trees are too tall to straddle with a tractor.

After Fourth Growing Season — Once shearing is started, a tree must be sheared each year until ready to harvest. Leaders of trees being sheared for the first time should be sufficiently shortened to reduce tree heights to 4½ to 5 feet. Trees that were pruned back to 4½ to 5 feet the previous year should have their leaders shortened to about 12 inches this year and every year thereafter until ready to harvest.

Continue broadcast spraying to control grass and weeds. Mowing or spot spraying between rows may also be necessary to control hard-to-kill grasses and weeds that shade the bottom whorls.

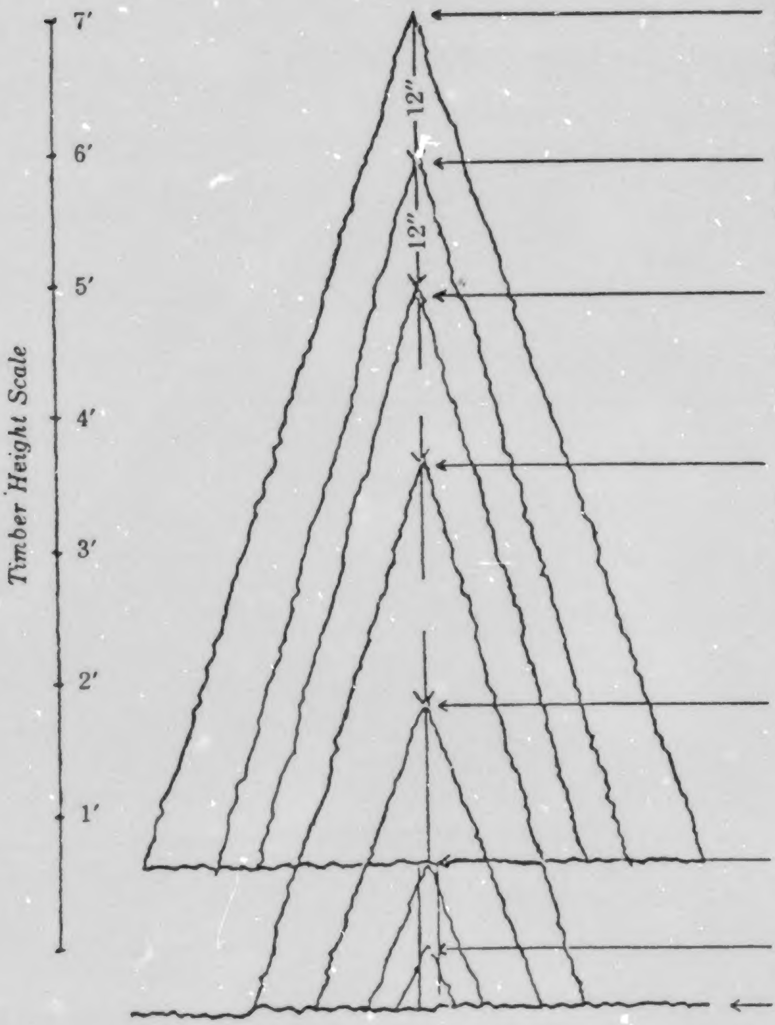
Basal prune the slower developing trees that were too small to have this done last year.

After Fifth Growing Season — Continue leader pruning, side shearing, correcting defects and spraying or mowing.

Most trees are not yet ready to harvest and they should be sheared to a 50 percent cone as previously described. However, a few trees will probably be ready to harvest this year after only three consecutive shearings. Carefully finish-shear them in late summer or early fall as follows:

a. Cut the leader in proportion to the rest of the crown to form a sheared cone. Usually about an 8- to 12-inch leader will accomplish proper proportion.

Development of a 7-foot Sheared Douglas-Fir in 6 Growing Seasons by the 5′ method of Progressive Leader Pruning



4th shearing — after 6 growing seasons — *Prune leader to 12". Shear to 60% taper.*

3rd shearing — after 5 growing seasons — *Prune leader to 12". Shear to 50% taper.*

2nd shearing — after 4 growing seasons — *Prune leader sufficiently to reduce tree height to 5'. Shear to 50% taper. Basal prune.*

1st shearing — after 3 growing seasons — *Leader unpruned if tree height less than 5'.*

Shear to 50% taper if natural taper exceeds this amount.

Crown unsheared after 2 growing seasons.

Unsheared after one growing season.

Bottom of 7" handle and top of planted seedling.

← *Ground level.*

b. Side shear lightly to form a near perfect cone. Shearing lightly will increase the percent taper from about 50 percent for previous shearings to about 60 percent for the last shearing. This widening will eliminate most of the visible stubs.

After the Sixth and Seventh Growing Seasons —Continue the same cultural treatments described for the fifth growing season. Most growers should plan to harvest all remaining marketable trees after the seventh growing season. Any leftovers that do not shape up properly should be sold at a reduced rate or discarded.

Site IV lands will likely require 8- to 9-year rotations instead of 7 unless fertilizers are used to stimulate faster growth.

9. Planning the Next Crop.

A douglas-fir plantation is normally harvested over a 3- to 4-year period. Cull trees are removed, stumps cut flush with the ground, and any live branches or suckers removed from the stump. For establishing the next crop of trees, the grower has a choice of first removing the stumps or replanting between the stumps. If he elects to remove the stumps, costs will likely be $75 to $100 per acre. One method is to plow them under with special heavy plows pulled with a crawler tractor. A portion of the stumps are buried beneath the planting depth, leaving others on or just under the surface. These can be windrowed with a spring-toothed cultivator. Another method is disking with a huge land-clearing disk pulled with a large crawler tractor. Two diskings at right angles from each other are normally required. This procedure breaks up most of the roots and stumps and mulches the soil to a depth of 12 inches or more. Large chunks are removed as previously described. Another successful method uses a heavy duty rototiller which pulverizes most of the stumps and roots after several passes. The last, and probably most expensive method, is removing the whole stumps with a bull-dozer and piling them for burning.

If the grower elects to leave the stumps in place and plant midway between them, the stumps will rot out in about 4 years. This procedure is common on U-cut operations where it is desirable to maintain maximum production with an uneven or mixed species stand. It is also used where heavy stump removing equipment is unavailable or too costly to hire. Some growers gain a year's growth by planting a new seedling midway between trees that are planned for cutting during the next harvesting season.

Most growers prefer to remove the stumps and start over with a new even-aged plantation. This practice provides opportunity to eradicate atrazine-resistant plants, which tend to gradually invade old plantations. It also deeply cultivates the ground and permits working nutritive additives into the soil.

In rare instances, stump culturing is practiced on plantations by leaving a few branches or sprouts on the base of the stump. This type of management could preserve an unusually desirable and hard-to-replace seed source or elite trees established from grafts or rooted cuttings. However, stump cultures in plantations are more difficult and costly to maintain than newly-planted seedlings and are not generally recommended.

C. DEVELOPING A NATURAL STAND

1. Site Selection

Although about 90 percent of sheared Douglas-fir are now produced in plantations, shearing in natural stands is a growing trend. Many growers in the southwestern Puget Sound area are beginning to convert unsheared Christmas tree stands to sheared stands by gradually removing the high pruned overstory and shearing trees at a lower level. Other growers manage and produce both sheared and unsheared trees on the same area by shearing only those trees that do not shape up naturally. Although natural stands have been sheared over a wide range of sites, low site lands (Site IV and V) in the southern Puget Sound area have produced particularly good results. A big advantage of this area is that ferns and brush do not grow tall and compete with lower branch whorls. However, the trees need to be fertilized with nitrogen for best results. Fertilizing, in effect, raises the site under the dripline of the tree and artificially stimulates growth rate and vigor to a degree where the trees respond well to shearing. On the other extreme, High Site I and II naturally stocked lands frequently produce growth that is too coarse and rapid for good shearing response. Also, hardwood trees, brush, bracken ferns and other competing plants grow quite rank on these areas and are difficult and costly to control.

Natural areas suitable for shearing should be adequately stocked with reproduction 3 to 6 feet in height. Excessive amounts of tall fern, competing hardwoods and unwanted coniferous species should be avoided because they greatly increase the cost of culturing. Consider also the advantages of gentle terrain, a good road system, lack of severe fire hazard and effective trespass control.

2. Thinning and Hardwood Control

The following treatments are the first ones required to develop a sheared natural stand. These differ very little from those used to develop unsheared trees in a natural stand.

a. Remove hardwood trees and brush. Control stump sprouting by a directed spray of brush-killer herbicides on freshly-cut stubs.

b. Remove larger overstory Douglas-fir (except possibly one or two high-pruned seed trees per acre) and also hemlock, cedar, and other unwanted coniferous species.

c. Space-thin the smaller Douglas-fir. Strive for an average spacing of about 5 feet. Somewhat closer spacing may be utilized where there is sufficient spread of heights to prevent crowding both at present and within the next few years while the overstory is developing. Save only those trees with the highest Christmas tree potential and complete bottom whorls not higher than about 2 feet above the ground.

Shearing would probably not benefit this slow-growing tree. Its natural shape, height and density is already adequate. Better management would be to harvest it as an unsheared tree after spring fertilizing to improve needle color and branch stiffness.

3. Basal Pruning

Basal pruning of natural stands is usually started at the same time that they are thinned. Benefits and techniques of basal pruning are essentially the same as those previously described for plantations. The selected bottom whorl should contain at least four or five well distributed vigorous branches in a *main nodal whorl.* It is usually desirable to locate it only a foot or two above the ground to facilitate easy reach for shearing the tree. However, the basal whorl should be located above any heavy ground cover that cannot be cut back or eliminated. In order to prevent overshock to the tree, basal pruning should be deferred until the tree has attained sufficient size that pruned limbs will not exceed about one-third of the total foliage. Some growers avoid overshock by basal pruning in stages over a period of several years. The first stage should always begin at the selected bottom whorl and progress downward on the stem as far as the above "one-third rule" will permit.

4. Shearing

Shearing techniques for natural grown Douglas-fir are quite similar to those already described for the plantation grown trees. In fact, a customer buying a sheared Douglas-fir might have difficulty knowing whether it was cut in a plantation or natural area. However, there are some differences in the way sheared natural stands and sheared plantations are managed.

Two successive light shearings have created this marketable, light density tree. The visible internodal openings between whorls are desired by many consumers for hanging pendulent-type ornaments.

[redacted]

Pointed out is where an excessively long leader was sheared last year on a cultured natural tree. A new leader developed from a single internodal bud left ¼ inch below the cut. At the same time, a false whorl developed from a cluster of internodal buds 3 inches below the cut.

Natural trees take several years longer to develop than plantation trees, even when site quality is the same on both areas. This is due in part to growth retardation during early stages of development caused by competition of brush, ferns and tall weeds commonly associated with natural stands. Natural trees also take several additional years to develop a bottom whorl above the shade level of this ground competition. Since high crowns are relatively difficult to reach with shearing tools, the bottom whorl should be located as close to the ground as possible without causing it to be suppressed.

Two general types of sheared trees are produced on natural areas:

a. Heavy density trees can be produced by fertilizing under the dripline one year prior to shearing and making repeated applications every other year. Three or four consecutive shearings are normally required to produce heavy sheared trees. Shearing and leader pruning practices are essentially the same as described for developing plantations.

b. Light density trees are usually produced by only 2 or 3 consecutive shearings, together with nitrogen fertilizing and pruning the leaders somewhat longer than 12 inches.

Shearing techniques for creating light density sheared trees in natural stands are different from those used to develop heavily sheared trees. The purpose of light shearing is to narrow the taper, perfect the cone-shape and increase the density, but still preserve a visible degree of natural internodal spacing between the whorls. This is accomplished by maintaining an annual leader length of 10 to 14 inches after the tree has attained a height of about 5 feet. Concurrently with cutting back the leaders, the tips of the main lateral branches are sheared back very lightly to form a near-perfect cone-shape. Resulting taper of 60 to 80 percent is wider than for heavily sheared trees.

Considerable potential exists for growing lightly sheared trees in the southern Puget Sound area where production of unsheared, cultured natural trees has been centered for many years.

5. Fertilizing with Nitrogen

Fertilizing natural stands of Christmas trees with nitrogen has become a very important cultural aid. It is used to improve the color, luster and size of needles and also to increase the growth rate, stiffness and vigor of leaders and branches. A bulletin published by the Washington State University Cooperative Extension Service provides detailed information on the subject. Some highlights from this reference follow.[6]

Slow growth Sites (Low III, IV, and High V), such as those found in Kitap and Mason Counties in Washington, are most likely to benefit from nitrogen. Trees growing on these relatively infertile, dry sites frequently grow excessively slow and have short needles, weak branches and poor color. Nitrogen will correct all these deficiencies. If the objective of fertilizing is to improve *both* needle appearance and growth rate, nitrogen should be applied every other year in March, starting when the trees are 3 or 4 feet in height. If the objective of fertilizing is to improve the needle vigor and color *without* greatly increasing growth rate, as in the case of unsheared or very lightly sheared trees, nitrogen applications should be deferred until the bud swelling period in April. It should be applied either the same year that the trees are harvested or one year previous to harvesting. If the trees are not harvested the same year they are are fertilized, delayed-action growth stimulation will likely occur during the following year. This usually necessitates shearing back the excessive growth to improve the shape and narrow the taper.

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[6] Darrell O. Turner and Joseph Buhaly, Washington State University, "Fertilizing Natural Douglas-fir Christmas Trees," Extension Bulletin No. 585, May 1966.

This canvasback carrier was designed especially for applying granulated fertilizer. It is easier to handle than a bucket and reduces spillage.

Nitrogen fertilizers, such as urea (46 percent nitrogen), ammonium nitrate (33 percent nitrogen), and ammonium sulphate (21 percent nitrogen), have usually proven to be more economical and just as effective as balanced fertilizers. However, some soils are deficient in both nitrogen and sulfur. Under these conditions, ammonium sulphate may be the most effective form of nitrogen to use. Urea-sulfur and ammonium sulfate combine the benefits of nitrogen and sulfur.

Individual tree application is the recommended method. Unlike broadcast application, it permits varying the amount of fertilizer and year of application to suit the needs of individual trees. It also prevents growth stimulation of brush, ferns and other ground cover between the trees. Granular type fertilizer is preferred because it is easy to carry and spread under the dripline of the trees by means of a 5-gallon bucket, backpack carrier or machine blower.

Amount of nitrogen per tree should be determined by trial and error for the least quantity that will do the desired job of needle improvement or growth stimulation. Suggested trial rates are ¼ to ¾ pound (actual nitrogen weight) per 6-foot tree crown. Experiments on low site lands in Kitsap County, Washington indicate that ¼ pound of nitrogen per tree will not increase growth appreciably the first growing season after application, but will increase it about 75 percent during the following growing season.

Use of nitrogen increases the necessity and desirability of shearing. In effect, it raises the site quality of land on which it is applied. Prior to using fertilizer, an area may produce leaders only 8 inches long. These may increase to 16 inches during the second growing season after fertilizing. The grower is then faced with two alternatives. He can either sacrifice the tree by thinning it out as a cull or he can develop merchantable quality by shearing. Increasing numbers of growers are finding that fertilizing, followed by shearing, can be a profitable operation.

6. Planning for a Continuous Crop

The following practices are used to help insure a sustained yield of trees year-after-year on cultured natural areas.

Stump Culture — Stump culture is the practice of developing a new Christmas tree from a small limb or sprout left on the stump after a Christmas tree has been cut.

It should be considered where there is an inadequate stocking of natural seedlings to replace trees that are cut. To make this system work, a cluster or whorl of branches, making up not less than 10 percent of the total foliage of the tree, should be left on the lower stem below the handle and as *close to the ground as possible*. This foliage should be lopped back to about one-half of its original length when the tree is cut to stimulate vertical sprouts. A year or two after the tree is cut, the most promising multiple sprout is selected to form a new tree and all the others are removed. Competing leaders and branches are gradually removed as the sprout begins to form a new tree. Some growers have produced three or four successive Christmas trees from a single stump.

Results are relatively poor where a stump culture utilizes an upturned branch instead of a sprout. Whorl development on a branch is likely to be incomplete for several years. The resulting tree will not readily develop symmetric shape. If a limb does eventually form a symmetric crown, it is likely to be too high above the ground for easy shearing.

Seed Trees — Many managers of natural stands retain one or two acres of their best overstory trees for seed production to insure a perpetual crop of new seedlings. A common mistake is leaving an excessive number of seed trees per acre. They compete with the understory Christmas trees and appreciably lower both production per acre and quality.

Seed trees should be full crowned, healthy and should have good Christmas tree form to increase the probability that seedlings will inherit desirable characteristics. Trees should be left in pairs or small groups, where possible, to facilitate cross-pollenating of cones. They should be pruned high to reduce shading of Christmas trees, but not more than one-third of the live crown should be removed. Viable seed production usually starts when the tree is about 20 to 30 years old, but can be stimulated sooner by applying fertilizers.

Spot Planting — Where seed trees are lacking or, for some reason, do not provided an adequate stocking of natural seedlings, unstocked spots should be hand planted. Planting stock grown from local seed source is recommended. Planted seedlings should be spaced about 5 feet apart. Hardwood thickets sometimes form canopies too dense for survival of seedlings. They should be cut, and stump sprayed with a herbicide, to prevent sprouting before planting is attempted. Commonly used tools for spot planting on natural areas are planting hoes, planting bars, sturdy tiles, drain shovels and powered soil augers.

Developing a Two-Story Stand — When trees are basal pruned several feet above the ground, adequate growing space is often provided to start natural seedlings under their canopies. These will have a head start when the overstory Christmas trees are harvested and frequently develop into a replacement more quickly and with less work than needed to develop a stump culture. Trees with the best natural Christmas tree form should be selected for replacements and others, including poorly developed or excessive high stump cultures, removed.

Harvesting as a Method of Thinning — Harvesting should be planned to provide additional growing space for adjacent trees, as well as to remove trees that are ready to market. Trees standing alone and not touching or shading other trees can be left.

However, those that are crowded should be thinned to provide adequate growing space on all sides of those that are retained. Ideally, this thinning should be accomplished by harvesting the surplus trees for market. These provide a good source of supply for the 3-4-5-foot sizes. Unfortunately, many trees that need immediate thinning are not of sufficient quality to market. In this case it is better to sacrifice the poorer trees by thinning than to spoil the future quality of all the trees by leaving the area overstocked.

D. PROTECTION

Protection from damage by animals, insects, diseases, fire and trespass are covered in detail in the following publications:

"Growing Christmas Trees in the Pacific Northwest" PNW-6, Cooperative Extension Service, Washington State University, Revision May 1976.

"Insect Control Guide for Commercial Christmas Tree Growing" (Revised), Washington State University Extension Service, Nov. 1974.

"Pests and Disease Control Guide for Christmas Trees," C.S. Davis, E.E. Gilden, C.S. Koehler and A. H. McCain, Pub. 2994, University of California Cooperative Extension Service, Division of Agricultural Sciences, Revision January 1965.

"Why is My Evergreen Brown?" A.D. Partridge and J.A. Schenk, Idaho Agricultural Extension Service Bulletin 514, 1976.

"Wildlife Feeding Injuries on Conifers in the Pacific Northwest," William Laurence, Nelson B. Kverno and Harry D. Hartwell, distributed by Western Forestry and Conservation Association, Portland, Oregon, 1978. $3.00.

E. HARVESTING AND MARKETING

Refer to the following bulletin: "Christmas Tree Harvesting and Marketing for Pacific Northwest Growers," Bernard S. Douglass, U.S. Forest Service, Region 6, Portland, Oregon, 1979.

F. SOURCES OF ASSISTANCE AND INFORMATION

Most growers in Oregon and Washington belong to the Northwest Christmas Tree Association. Meetings, field tours, culturing demonstrations and current literature are provided for members. The name and address of the current secretary may be obtained by contacting any of the above-mentioned sources of information.

Both the Oregon State and Washington State University Extension Services provide biennial 2-day short courses for Christmas tree growers. Your local Extention Forestry Agent can provide information on time, place, and agenda of these training sessions.

Further information may be obtained from the Association Secretary.

The pesticide reported on and recommended here was registered for the use described at the time this manuscript was prepared. Since the registration of pesticides is under constant review by State and Federal authorities, a responsible State agency should be consulted as to the current status of this pesticide.

Pesticides used improperly can be injurious to man, animals and plants. Follow the direction and heed all precautions on the labels.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

Pacific Northwest cooperative Extension bulletins are joint publications of the three Pacific Northwest states — Oregon, Washington, and Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published over 200 titles. Joint writing, editing, and production has prevented duplication of effort, broadened the availability of faculty specialists, and substantially reduced costs for the participating states.

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Range Management

Plant Science --- Local Adaptation

Introduction:

This unit is provided as a Plant Science Local Adaptation Option Unit. There are six option units for plant science in this curriculum. Select the one which fits your program best. The six option units include:

1. Berry Production
2. Grass Seed Production
3. Nursery Production
4. Landscape Design
5. Christmas Tree Production
6. Range

Objectives:

Upon completion of this unit, the student will be able to:

1. Appreciate range ecology and condition and their relationship to management.
2. Rate their range.
3. Classify range plants.
4. Identify range plants.
5. Describe range plant growth and development.
6. Develop management strategies for range.
7. Understand range nutrition in relation to management.
8. Identify poisonous plants and range management alternatives.
9. Deal with drought in range management.
10. Understand transactions with Federal Land Managers.

11. Plan range use.
12. Develop and use grazing keys.
13. Understand grazing to maintain a healthy range.
14. Know how to improve range.
15. Use forage effectively for Beef Production.

References:

1. This unit uses the following extension circulars for its basis: Nos. 1039, 1040, 1037, 1038, 1036, 1045, 1046, 1048, 1049, 1047, 1043, 1041, 1044, and 1042.
2. Make wise use of local BLM and Forest Service Range Specialists.

Instructor Activities:

1. Copy the material here or get the extension circulars listed above.
2. Plan to use BLM and/or Forest Service Range Specialists to plan field trips.
3. Use local ranchers for field trips.
4. Have students make a plant collection of range plants.

Student Activities:

1. Make plant collection.
2. Study materials and participate in discussions and field trips.

Appendices:

1. Appendix A: Grass Plants Common to the Western Range:
   Common Western Range Plants
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407
2. Appendix B: Grass-like Plants Common to the Western Range:
   Common Western Range Plants
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407

3. Appendix C: Legume Plants Common to the Western Range:
   Common Western Range Plants
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407

4. Appendix D: Forbs Common to the Western Range:
   Common Western Range Plants
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407

5. Appendix E: Poisonous Plants Common to the Western Range:
   Common Western Range Plants
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407

6. Appendix F: Shrubs and Trees Common to the Western Range:
   Common Western Range Plants
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 83407

RANGE MANAGEMENT

I. Range Management

(Prepared by Thomas E. Bedell, Extension Rangeland Resources Specialist, Oregon State University, Corvallis)

A. Range Ecology and Condition--Their Relation to Management

Most soils form over a long period of time from weathered rock. They are affected by topography or position, by organisms, and by the climate that prevails in a local situation. The ability of soil to support life is affected by these factors. Soil depth, texture, structure, and color -- all are characteristics the land-owner learns about in order to improve soil and, therefore, plant production. The range soil resource can be improved or torn down by our management practices. Range soils characteristically are relatively shallow, occur on sloping as well as level terrain, and often are quite rocky. The total environment is harsh and range soils often have been discounted as a resource since they are not cultivated and cannot be cropped.

All aspects of soil are important, but the overriding influence for rangelands of the West is weather--moisture for plant growth, in particular. Moisture-holding capacity and the time of moisture availability to plants strongly influence what plants will grow and how they will grow on a particular location.

1. The Plant Community

The ability of a plant species to grow, reproduce, and survive is governed by five basic factors--the soil on which it grows, the location or position it has or topography, the time over which it has been there, the other organisms in its environment, including man, and the climate in the immediate area as well as overall climatic influences. In essence, soil and the plants thereon develop together and not independently of one another. When any of these factors is changed the plant species may change or the growth characteristics of the same species may be altered.

Plant species are adapted to different conditions. On any one area changes in plant species composition will occur with the passage of time. Some species are replaced by others that can grow and compete, and reproduce there. The progressive change through time is termed plant succession. A theoretical endpoint is called climax, as used in the term "climax plant community." This concept holds that a pinnacle of soil and plant development will occur, which is dynamic equilibrium. All usable spaces, called niches, are filled. The only disturbance accommodated in the concept is natural and outside the influence of man.

The concept has primary relevance for one major reason. Climax plant communities are important tools in characterizing what is termed a range or ecological site. When the climax community is composed of different species or sometimes of similar species but of different proportions, the sites on which such communities grow are different. Thus, the designation, "Ecological Site A, Site B, ..." The sites are given names according to the physical descriptions or to the major plant species which form the climax or potential plant community. To repeat, ecological sites are characterized by the total environment--soil, slope, climate, and species composition of the potential community.

2. Ecological Condition

This term, sometimes known as range condition, embodies management and incorporates the influences that man or other factor changes can have on the plant composition. To illustrate, plant species have varying tolerances to particular influences--grazing, fire, flooding, etc. Livestock eat plant species, as do wild animals and insects.

The reaction of plant species to grazing has been described in the context of decreasers and increasers or of invaders (those who were not present in the climax community). This concept says if a climax plant community were grazed repeatedly, in whatever manner, that some species would decrease, that some would increase, and if the activity went on long enough, that some species (very often annuals) would invade.

The same concept can apply to other influences--fire as an example. Some shrubs are tolerant to fire and sprout back; others are killed and reproduce by seed. If both big sagebrush and gray rabbitbrush occurred with resident bunchgrasses and a fire occurred during a season when bunchgrasses were not damaged, the rabbitbrush would act as an increaser to the influence of fire whereas the sagebrush would act as a decreaser. In time, seedlings would come in. If the same plant community were strongly influenced by grazing, the responses could be different. Some grasses would decrease and some would increase, whereas both shrubs would increase. This sounds confusing but it is what happens. This complex relationship demonstrates the importance of all the interwoven issues of site, weather, species, and management.

The departure from climax, for whatever reason, is termed as excellent, good, fair, or poor ecological condition, and is expressed as a percent of the potential community in terms of its species composition. This is a way of describing the range on its successional or ecological gradient. In other words, for each site that has been studied, a particular species composition will fit one of the condition classes. Management can deal with this concept because we can recognize an ecological site on the ground, map it, and describe the ecological (range) condition, which probably varies from place to place throughout the site. Forage productivity is not always highest in a climax grassland or shrub-grass plant community, but for general considerations on most sites, it will be. Managing for excellent condition may be impractical; in fact, it often is. Climax herbaceous plant species are not necessarily the most preferred species. The important point is to know that the species that occur are a way to "read the range," and through various practices, you can adjust species composition, forage production, and ecological condition.

Forested plant communities must be viewed in a different ecological context. Since succession proceeds toward trees from the point after logging, the more the canopy closes in, the closer to excellent condition, and the lower the production of the herbaceous understory. From a grazing standpoint, excellent condition is poor and poor condition (when herbaceous plants should abound) is desirable. Poor ecological condition of a forest situation is probably desirable game habitat, too.

3. Using the Ecological Condition Concept

Building on the knowledge that ecological or range condition is a way to describe vegetation, it follows that with enough knowledge about the productivity by condition for a site, objectives can be phrased in terms of condition. As stated before, except for forested communities, an improvement in ecological condition often means an increase in forage production. Managing for high or good condition on all ecological sites becomes a management goal that can be measured. Species composition at present determines where we are. If the successional patterns are known, we can recognize when goals are being reached.

Without knowing the successional changes, managers can either (1) expect more progress to be made than is possible for the site and be dissatisfied with results, or (2) not be taking advantage of the site potential. In either case, you need to know what plant species shifts will occur for each site as ecological condition changes.

4. Trend in Condition

Upward-downward-stable---these represent trend in range-condition terms. Trend in condition for a site is determined at two points in time, preferably at least 5 years. Exercise caution in interpreting what you find. Very good and very poor precipitation years can affect production and relative species composition. You would expect faster recovery when good years occur and the converse in poor years. Accurate production records to supplement trend information will aid in its interpretation.

5. Management Affects Condition

Cattle can be managed to influence condition. By knowing inherent grazing preferences and adjusting seasons of use and numbers of stock, some plant species will increase and some will decrease. Removing grazing pressure to allow plants to grow back is important. The proportion of cool and warm season species, and even the proportion of annuals to perennials, may be influenced directly by cattle management.

Plant communities can be "shocked" into more rapid condition changes under some circumstances. Using appropriate herbicides has considerable merit. Invading species such as fringed sagewort can be sprayed from plains grassland and succession speeded up. Some grasslands that are heavy to forbs can be sprayed, or even fertilized, allowing grasses to increase and hastening succession. Big sagebrush spraying will reduce the increased brush, allowing more ecological stability and at the same time higher forage production. Fire has an ecological role. Some species are tolerant of fire and can survive and prosper under periodic burning. Other species are not tolerant of fire. Western juniper and certain other non-sprouting junipers are examples. They are confined to rocky sites where there is insufficient fuel to carry fire. But, in the absence of fire they have spread onto better soils and over time have become dominant.

B. Rating Your Range

Perhaps only one really good reason exists for rating (evaluating) your range--you need to know its status in some detail in order to know whether improvement is occurring or you just think it is occurring. Don't trust your memory. Use a simple, straightforward scheme on a rather regular basis. You will find a record helpful in planning better future management.

You should know the status of soils and vegetation on your range and pasture areas. Is the surface stable? Is there soil movement? By what force? How much and where? What is the relative plant vigor and production? Is it satisfactory? If not, can you pinpoint why? Is it something your can control?

Rate your own private range and your leased range, especially that managed by federal agencies. Knowing how to rate should help you greatly when dealing with resource managers. Use the same methods they do, if possible. Or, use something similar to the scorecard approach proposed in this circular. It will help you determine what is the true situation.

For long-range management planning, especially in semi-arid rangelands, assessing soil conditions is critically important. Most managers desire to manage so soil stays in place. It is true that natural forces will move soil downslope, even with good management, and we have little control of where soil will be deposited after it starts to move. Consequently, retaining it in place makes good sense. Evaluating your range will tell you the current situation in some detail. It does not tell the cause. Soil can move because of lack or shortage of litter. Unusual or accelerated soil disturbance can be caused by too many animals or by man's activities. Slope and texture also have a great effect. The person doing the rating needs to determine what the best situation looks like in order to determine the amount of deviation.

Recognize the effects of soil texture. Light-textured (sandy) soils can be moved by wind from plant interspaces to the plant crowns. Heavier-textured (clay) soils heave as a consequence of repeated freezing and thawing. Pedestalling of plants, where the soil appears to be, or actually is, removed from around the plant, can result from soil movement or from freezing and thawing, which lifts plants, creating a similar effect. Make note of this. You need to know whether the soil was being moved or whether the plants were lifted up.

Know the difference between desert pavement and erosion pavement. Pavement refers to rocks of varying size on top of the soil. The common thought would be that soil was washed or blown away. In fact, rocks protect the surface from high winds and heavy water events. Desert pavement is a result of long-time freezing and thawing so that rocks end up on the surface. Erosion pavement results when the surface horizons and organic matter are washed or blown away, leaving rocks.

Assess effects of storms on similar areas that are grazed versus those which are not. Record the intensity of storms. If real differences occur, and the differences appear to be due to grazing, this will tell you where your management actions need be concentrated.

Look at plants as intensively as the soil. To rate a range, plant identity must be known. Assess the state of plant health on at least a species-grouping basis. The rating should tell you how capable the range or pasture is for maintaining the most desirable plant productivity. Therefore, look at all of the plants--how vigorous they are or how weak, whether they are reproducing, whether there are many or few undesirables present and, if present, the locations where they may be concentrated. Look at levels of grazing use and decide if a different species might be preferred. Determine whether there is an effect of differential grazing on vigor.

Whether you use a scorecard or just make notes, record your observations so the same locations can be rated in subsequent years. It may be impractical to rate every site, so establish benchmark areas. The ratings can be made at any time of year, but may be done better after the grazing season than at other times.

The rating form suggested here uses a simple, subjective approach. Agency rating forms or scorecards use numbers, so a numerical rating can be made each time the area is rated. A rating form used by the Bureau of Land Management also is shown. Regardless of the form you use, remember that it is important to rate the range, record observations, and use them to make your management better.

A Form for Recording Range Rating

Pasture or range ______________________________ Date ______________

Location within pasture ______________________________ Observer ______________

Kind of site ______________________________

Terrain ______________________________ Kind of growing season ______________

Plants				
Species composition	Good	Fair	Poor	
Ground cover				
Desirable species	High	Medium	Low	
Undesirable species	High	Medium	Low	
Vigor				
Desirable grasses and forbs	High	Medium	Low	
Desirable shrubs	High	Medium	Low	
Undesirable grasses and forbs	High	Medium	Low	
Undesirable shrubs	High	Medium	Low	
Grazing Use	None	Light	Moderate	Heavy
Poisonous-noxious species	None	Scattered	Common	Abundant
Soil				
Litter	High	Medium	Low	
Surface protected by	(rocks, twigs, litter, other)		Adequate	Inadequate
Pedestalling of perennial grasses	None	Slight	Moderate	
Surface movement by water	None	Slight	Moderate	
Surface movement by wind	None	Slight	Moderate	
Gullies	None	Few	Several	
Condition (if applicable)	Sloughing and getting worse		Revegetating and healing	

Notes

AgIII-XVII-12

Range Rating Example

Pasture or range COYOTE BUTTE

Date JULY 14, 1980

Location within pasture NORTH END

Observer JOE SMITH

Kind of site LOAMY UPLAND

Terrain ROLLING

Kind of growing season COOL, LATE RANGE IMMATURE

Plants				
Species composition	Good	[✓ Fair]	Poor	
Ground cover				
Desirable species	High	[✓ Medium]	Low	
Undesirable species	High	[✓ Medium]	Low	
Vigor				
Desirable grasses and forbs	High	[✓ Medium]	Low	
Desirable shrubs	High	[✓ Medium]	Low	
Undesirable grasses and forbs	[✓ High]	Medium	Low	
Undesirable shrubs	[✓ High]	Medium	Low	
Grazing Use	None	Light	[✓ Moderate]	Heavy
Poisonous-noxious species	None	[✓ Scattered]	Common	Abundant
Soil				
Litter	High	Medium	[✓ Low]	
Surface protected by	(rocks, twigs, [✓ litter], other)		Adequate	[✓ Inadequate]
Pedestalling of perennial grasses	None	[✓ Slight]	Moderate	
Surface movement by water	None	Slight	Moderate	
Surface movement by wind	None	Slight	Moderate	
Gullies	None	Few	Several	
Condition (if applicable)	Sloughing and getting worse		Revegetating and healing	

Notes

AgIII-XVII-13

BLM Range Rating Form

Range Site Symbol ____________________ Date ____________

Condition Class Symbol ____________________ Examiner ____________

Legal Description ____

OBSERVED APPARENT TREND

(Check appropriate box in each category which best fits area being observed)

VIGOR (10 points)	☐	Desirable grasses, forbs, and shrubs are vigorous showing good health. These plants should have good size and color and produce abundant herbage.
(6 points)	☐	Desirable grasses, forbs, and shrubs have moderate vigor. They are medium-sized with fair color and produce moderate amounts of herbage; some seed stalks and seedheads are present.
(2 points)	☐	Desirable grasses, forbs, and shrubs have low vigor. They appear unhealthy with small size and poor color. Portions of clumps or entire plants are dead or dying. Seed stalks and seedheads almost non-existent except in protected areas.
SEEDLINGS (10 points)	☐	There is seedling establishment of desirable grasses, forbs, and shrubs. Seedlings are present in open spaces between plants and along edges of soil pedestals. Few seedlings of invader or undesirable plants are present.
(6 points)	☐	Some seedlings of desirable grasses, forbs, and shrubs may be present in open spaces between plants. Some seedlings of invader or undesirable plant species may be present.
(2 points)	☐	Few if any seedlings of desirable grasses, forbs, and shrubs are being established. Seedlings of invader or undesirable plants should be present in open spaces between plants.
SURFACE LITTER (5 points)	☐	Surface litter is accumulating in place.
(3 points)	☐	Moderate movement of surface litter is apparent and deposited against obstacles.
(1 point)	☐	Very little surface litter is remaining.
PEDESTALS (5 points)	☐	There is little visual evidence of pedestalling. Those pedestals present are sloping or rounding and accumulating litter. Desirable forage grasses may be found along edges of pedestals.
(3 points)	☐	Moderate plant pedestalling. No visual evidence of healing or deteriorating. Small rock and plant pedestals may be occurring in flow patterns.
(1 point)	☐	Most rocks and plants are pedestalled. Pedestals are sharpsided and eroding, often exposing grass roots.
GULLIES (5 points	☐	Gullies may be present in stable conditions with moderate sloping or rounded sides. Perennials should be establishing themselves on bottom and sides of channel.
(3 points)	☐	Gullies are well developed with small amounts of active erosion. Some vegetation may be present.
(1 point)	☐	Sharply incised V-shaped gullies cover most of the area with most of the gullies actively eroding. Gullies are mostly devoid of perennial plants with fresh cutting of the bottom.
Total Points		Rating: 26-35 = Upward; 17-25 = Static; 7-16 = Downward

General Coments: ____

Taken from BLM, EIS, Drewsey Resource Area, Oregon.

C. Range Plants--Foundation of the Grazing Resource

Range owners and managers should learn the identity of the important plant species. Each has a scientific name and a common name. It is important that proper nomenclature be used because some plants are known by more than one name and some names are used for more than one plant.

Why learn a plant's identity?

1. It is necessary when you inventory
2. You can't rate your range without knowing the main species
3. Some species are grazed more than others
4. Some are more productive
5. Some are undesirable, for whatever reason
6. Some indicate particular site conditions and particular ecological conditions

Grasses, generally, are the most important plant category for beef producers, and this category is emphasized here. Each plant has specific parts with particular functions. Those for grasses are described next.

Plants usually have roots, crowns, stems, leaves, and seedheads. To tell one plant from another, you must know the names of the main parts and their differences. This is shown under "Grasses."

Roots, unlike stems, have no joints, leaves, or flowers. The root's growing part is at the tip. The main functions of the roots are to take water and minerals from the soil to the stems, to store food over winter for spring growth, and to anchor the plant in the soil.

Rhizomes are actually creeping underground stems with joints and leaflike scales. You may have seen quackgrass or western wheatgrass rhizomes producing a new plant. Rhizomes store food and reproduce new plants.

Stolons are like rhizomes, except they grow above the ground. They do the same job as rhizomes, foot storage and reproduction.

Above ground, a plant may be divided into vegetative and flowering parts. Vegetative plant parts include the stems and leaves. The grass stem is made up of nodes (joints) and internodes (between the joints); it is usually hollow but sometimes has pith in the center, similar to corn. The main functions of the stem are to transport water, minerals, and food between the roots and the leaves and to support the leaves.

At each node (joint) on the stem, there is a bud, which may reproduce a branch or remain dormant. The leaf is made up of two parts: the sheath, which fits closely around the stem; and the broad, expanded portion known as the blade. These two parts are jointed together at the collar, which has two parts. On the inside of the collar, next to the stem, is a small leaflike projection known as the ligule. On the outside of the collar, on some grasses, are two ear-shaped tips that clasp the stem. These tips are called auricles.

The growing point of the grass leaf is at the base of the leaf and the sheath rather than at the tip. That explains why grass leaves can be grazed and still grow and produce forage for livestock. The growing point of herb stems is at the tip. When the tip is grazed or slipped off, the stem quits growing.

The "flower" or head of a grass plant is made up of many smaller units known as spikelets. At the base of each spikelet there are two leaflike bracts known as glumes. When there is more than one floret (single grass flower) in each spikelet, each floret is supported on a short stem known as a rachilla. Each of these florets at maturity produces a seed. The seed is enclosed by two more leaflike bracts known as the lemma and the palea. In many grasses, such as bluebunch wheatgrass, the lemma and palea remain with the seeds after they ripen and fall.

If you do not have an identification key and need to know the name and importance of a plant, take the plant to your county Extension agent or to some other range technician. If they cannot identify it for you, keep one specimen and send another one to your Extension range specialist or to the herbarium of your state college or university. When collecting plants for identification, you should collect the entire plant. It will aid in identification and shipping or storing in a collection if you press each specimen.

Plants can be grouped according to how long they live and how they grow.

Annual plants live only one season. They must reproduce each year from seeds. They do not grow a second year from roots or crown. Examples are cheatgrass and Russian thistle.

Biennial plants live 2 years and reproduce by seeds the second year. Yellow sweet clover is one. There are not biennial grasses.

Perrennial plants live over from year to year, producing leaves and stems for more than 2 years from the same crown. These plants reproduce by seeds, stems, bulbs, and underground rootstocks. There are both short-lived and long-lived perennials.

Plants grown in different seasons of the year. Cool-season plants make their principal growth during the cool weather in the spring or late fall. Warm-season plants generally make their principal growth during the frost-free period and develop seed in the summer or early fall.

Plants are also grouped according to their growth form, that is, their shape or how they look as they grow. Because range plants are so numerous and so different in their forms and growth habits, they should be grouped for convenience in range management. There are five main kinds of plants: grasses, grasslike plants, forbs, shrubs, and half-shrubs.

Following is a description of the kinds of common range plants.

1. Grasses

   Grasses and plants with jointed stems; stems are generally hollow, leaves are in two rows on the stem; veins on the leaves are parallel. These are "true grasses" and are among the most important kinds of range plants. Examples are:

   a. Bluebunch wheatgrass (perennial bunchgrass)
   b. Quackgrass and western wheatgrass (perennial with creeping underground stems or rhizomes)
   c. Cheatgrass brome (an annual grass)

2. Grasslike plants

   These plants look like grass, but have solid (not hollow) stems which are either triangular or round and have no joints. Veins are parallel in the leaves. These are sedges and rushes. Examples are:

a. Elksedge (triangular in cross section)
b. Baltic rush (round in cross section)

3. Forbs

A forb is a non-grass plant with annual stems (tops). There are usually netlike veins in the leaves. Examples are weeds and range flowers. We use the term "forb" instead of "weed" because weeds are best thought of as undesirable plants. Many of this group of range plants are not pests, for they are valuable as forage, especially for sheep and wildlife. Examples are:

a. Yarrow (perennial creeping rhizomes)
b. Tapertip hawksbeard (perennial roots)
c. Bull thistle (biennial roots)
d. Tumbling mustard (an annual forb)

4. Shrubs

A shrub is a woody plant; its stems and buds live over the winter above the ground and branch from near the base. (A tree resembles the shrub in growth form, but the tree has a definite trunk with branches well above the ground.) Examples of shrubs are:

a. Big sagebrush
b. Rabbitbrush
c. Bitterbrush

5. Half-shrubs

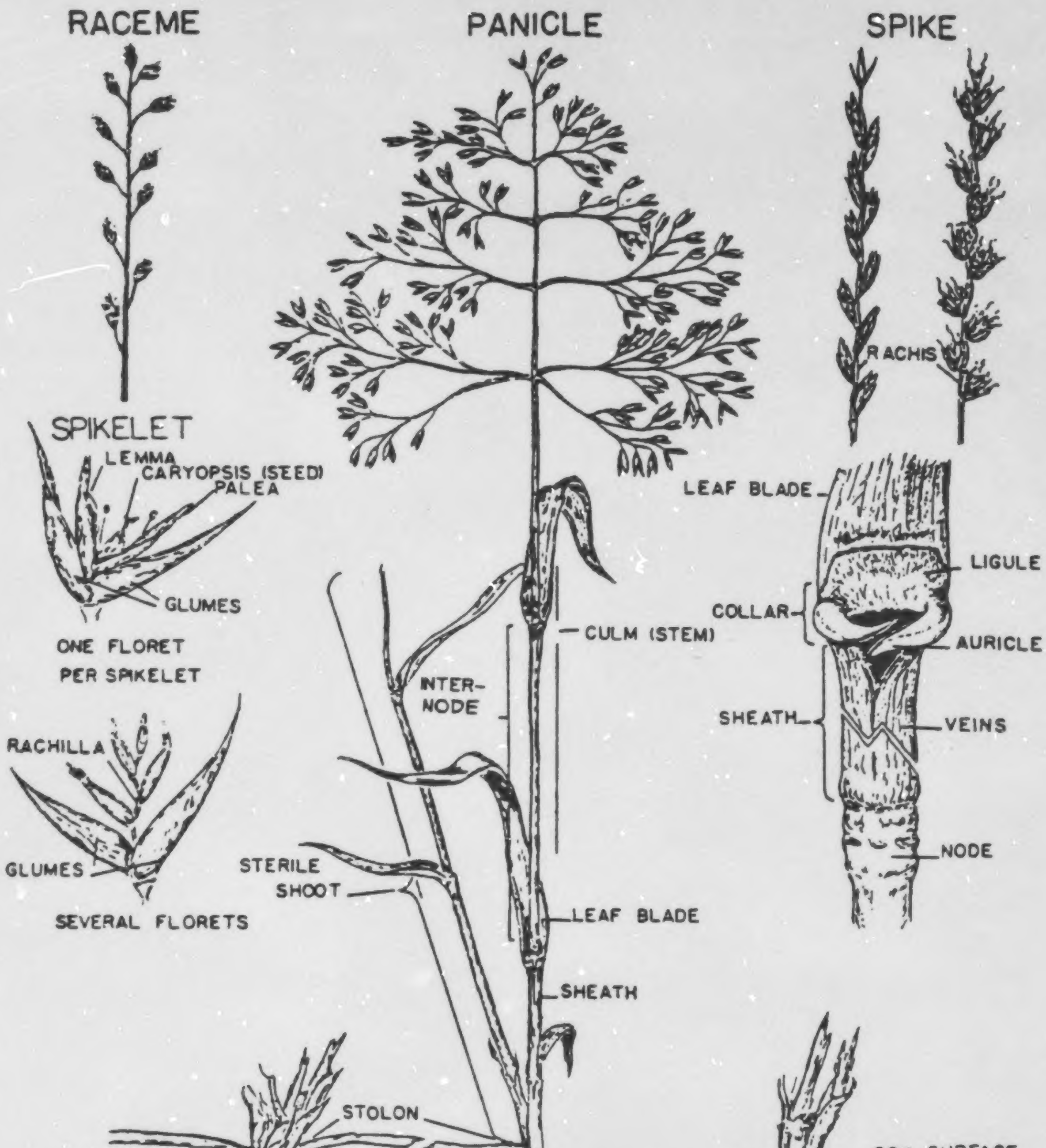
A half-shrub is a perennial plant that dies back each winter, not to the ground line, but to a perennial woody base or a bare ground stem. Examples are:

a. Matchweed
b. Winterfat

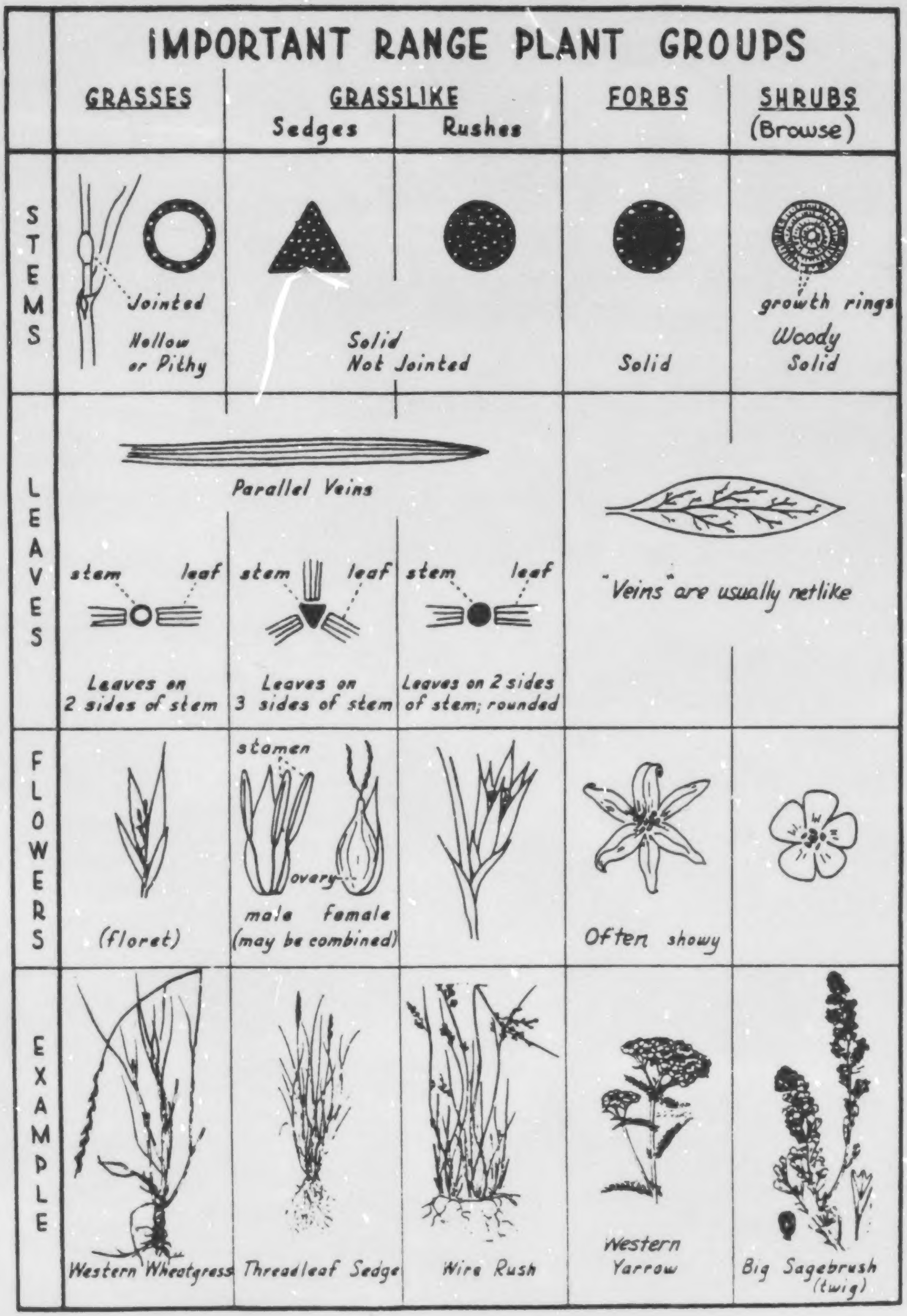
By knowing the groups of plants and plant parts, you can use an identification key. A key is an organized listing of plant characteristics according to structure (generally, flower parts). Plant keys are helpful in determining the correct names of plants.

See your Extension agent or range technician for a key to range plants in your county or state.

THE GRASS PLANT


RACEME
PANICLE
SPIKE
RACHIS
SPIKELET
LEMMA
CARYOPSIS (SEED)
PALEA
GLUMES
ONE FLORET PER SPIKELET
RACHILLA
GLUMES
SEVERAL FLORETS
LEAF BLADE
LIGULE
COLLAR
AURICLE
SHEATH
VEINS
NODE
CULM (STEM)
INTER-NODE
STERILE SHOOT
LEAF BLADE
SHEATH
STOLON
SOIL SURFACE
CROWN
RHIZOME

IMPORTANT RANGE PLANT GROUPS



	GRASSES	GRASSLIKE		FORBS	SHRUBS (Browse)
		Sedges	Rushes		
STEMS	Jointed Hollow or Pithy	Solid Not Jointed		Solid	growth rings Woody Solid
LEAVES	Parallel Veins			"Veins" are usually netlike	
	stem leaf Leaves on 2 sides of stem	stem leaf Leaves on 3 sides of stem	stem leaf Leaves on 2 sides of stem; rounded		
FLOWERS	(floret)	stamen ovary male female (may be combined)		Often showy	
EXAMPLE	Western Wheatgrass	Threadleaf Sedge	Wire Rush	Western Yarrow	Big Sagebrush (twig)

D. Range Plant Growth and Development

Green plants are the foundation of all life. Understanding how they grow and how grazing management affects growth is basic to range management. Grazing can hurt or help plants, depending upon when it occurs and to what extent. Knowing how various species function permits more than just improved grazing management. As an example, weedy species can be controlled by planning certain activities in accord with their most susceptible periods of growth.

Photosynthesis is the process by which the plant produces its own energy or food from the sun's energy by combining water, carbon dioxide, and plant nutrients in the presence of chlorophyll contained in the green leaf. A large number of factors affect the rate at which this process occurs; on range or pasture the most effective factor man can control is the time and level of leaf removal. The amount of energy produced relates to the amount of effective leaf area (number, size, and activity of green leaves).

Energy or plant food is also consumed by the process of respiration. This process continues as long as the plant lives. Perennials undergo dormancy periods of varying length each year. Throughout these dormant periods, plants remain alive through respiring some of their stored energy.

Except for evergreens, perennial plants must send up new leaves and start their growth cycle anew each year. In doing so, they depend on stored energy. Perennial grasses and forbs store energy in roots and crowns. Shrubs store it in roots, crowns, and twigs (buds). Old leaves of grasses and forbs are no longer living after growth ceases each year. Their removal then will not affect the level of stored energy since that energy was translocated from leaves to the storage sites earlier in the season. As a survival mechanism, plants have the ability to store excess energy, but this ability varies greatly among species. By the same token, perennial plants may not produce as much energy under some conditions, such as grazing or drought, as would be desirable for normal functioning, yet they do not necessarily die immediately. Thus, understanding the survival abilities of plants on your ranges has much to do with perpetuating their productivity.

The amount of new spring growth and its vigor depends on the level of energy stored the previous season. Roots begin growth before leaves, in some cases several weeks before. The general pattern of energy or carbohydrate decline or depletion is fairly similar among species but the pattern of storage is not. As much as 75 percent of the entire supply of stored energy may be needed for a plant to make as little as 10 percent of the next season's growth. So, energy or food reserves of perennial plants will be at their seasonal lows soon after early spring growth starts. The plant must get the opportunity to grow on past these early stages and start to restore or put back energy that is used. Most perennial grasses are still storing energy up to the time of seed maturity. In some species, such as bluebunch wheatgrass, at least one-half of the season's growth must be made before the energy level at the beginning of the season is reached. In other species, such as squirreltail, that level is reached by about the fourth leaf stage (Figures 1 and 2).

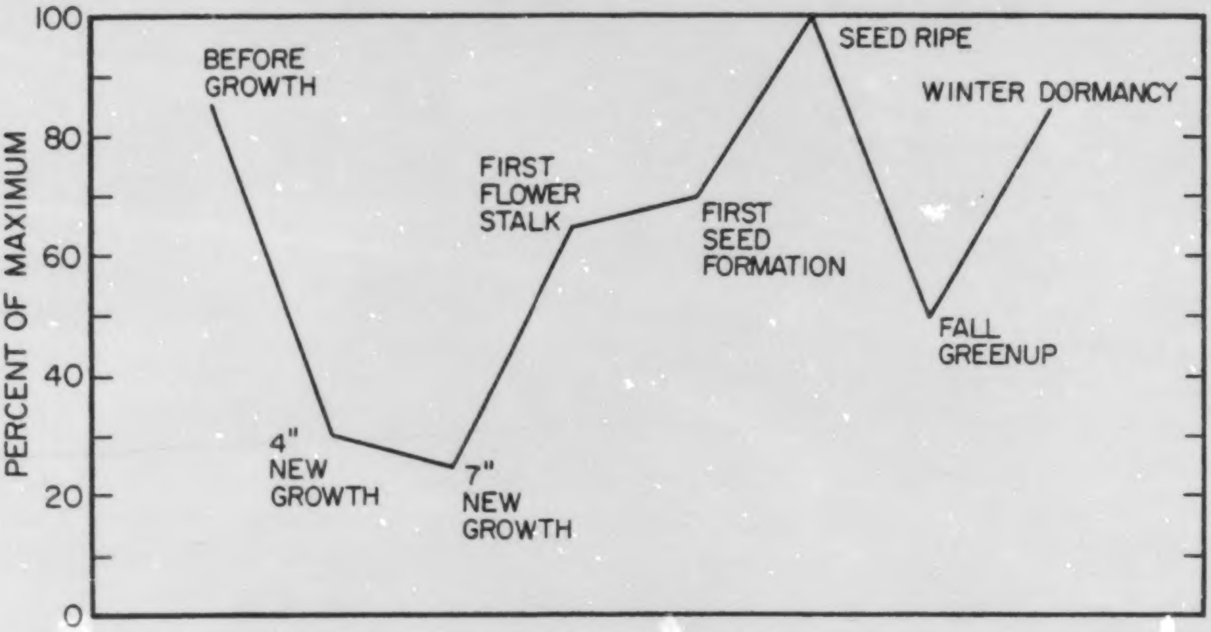


Figure 1. Available energy in roots of bluebunch wheatgrass at varying stages of maturity.

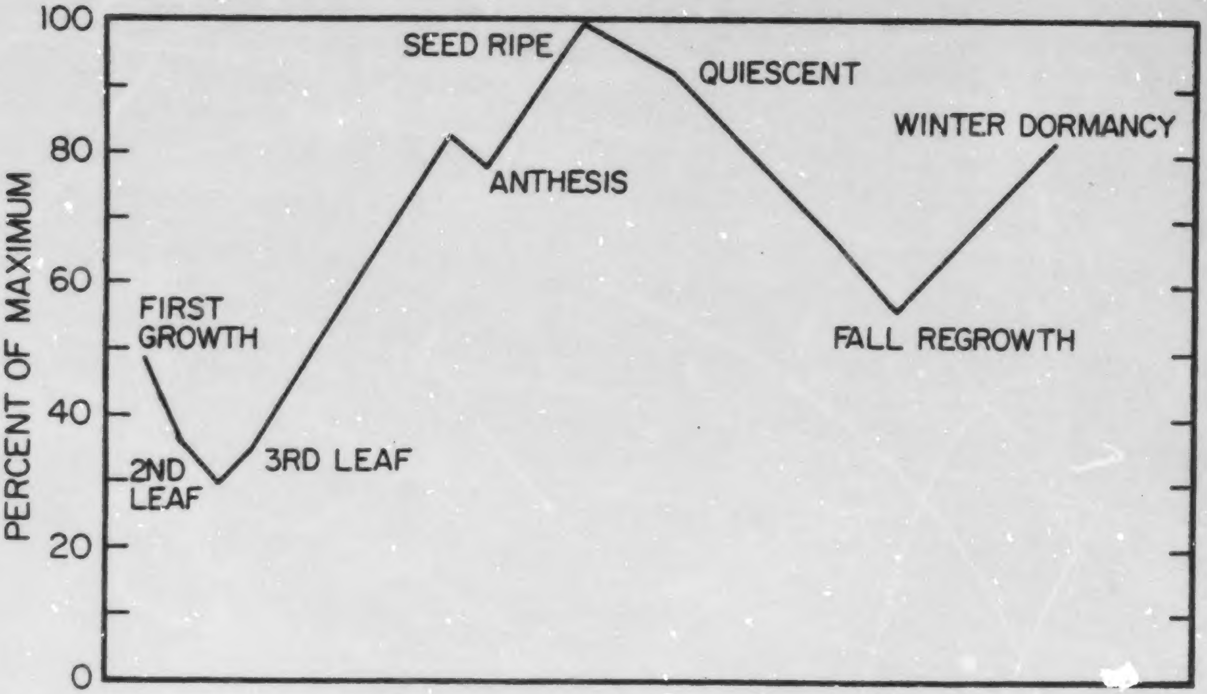


Figure 2. Available energy in roots of squirreltail at several stages of maturity.

Energy is needed at all times, but there are three especially critical periods in the life cycle. First is early spring when new growth is initiated. Energy is drawn out of storage. Next is the period of active reproduction from flower stalk to seed when energy comes from upper leaves currently producing it. Last is when fall regrowth occurs. Energy comes from storage here, too. In addition, plants need energy to replace grazed leaves and to withstand drought conditions. One of the reasons for range deterioration in the turn-of-the-century era was lack of knowledge and understanding about these processes by the livestock owner and operator.

Annual plants produce energy, of course, but their survival mechanism is their seed. Poor growing conditions, especially when combined with close grazing, cause the plant to have less active photosynthetic leaf surface resulting in slower growth and less viable seed produced. Perennials can survive quite well without producing viable seed although the level of seed production is a useful indicator of plant health. However, don't expect seed to be produced in the dry years.

Managed spring grazing and grazing after maturity do not greatly affect energy storage and seem not to be injurious to plants. Studies show that root growth is slowed and may be stopped by the level of removal of the tops. But, when less than 50 percent is removed from most species at this time, little to no effect takes place. If spring grazing is only for a short time period and is stopped while enough soil moisture remains to allow ample regrowth, the plant should restore the energy it needs. Grazing should not occur again until the plant has accumulated as much energy as it can for that season. When growing season moisture is very limited and plants are grazed severely, there will not be sufficient leaf area remaining for the plant to both extract remaining available moisture and restore its energy supplies. The size of the root system will be reduced, which will affect the ability of the plant to make normal growth the next year.

Low energy reserves, whether caused by past grazing practices or not, also weaken the plants' ability to tolerate cold winter temperature. The concentration of the cell sap is raised, which lowers the freezing point. Low food reserves result in reduced root growth and decreased drought resistance. In essence, a continuously closely grazed plant cannot supply its own needs and is being starved by lack of an active recharging mechanism.

Plants make their growth from buds, which contain meristematic or new-growth-generating cells. Susceptibility to grazing varies a great deal from plant group to group and, of course, from species to species. Buds of forbs and shrubs occur on branches and twigs. Whenever buds or growing points are removed before potential full growth is made, the plant's growth for the season may be impaired. If grazing can be rotated so bud removal would occur, followed by relief from grazing, new growth from lateral buds may keep up production. Depending on the species, the ratio of reproductive to vegetative or leafy twigs or stems will be different. This can affect the forage quality.

Grasses are uniquely suited to be grazed because the growing point is protected inside the plant for most of the growing season (Figure 3). Each stem or culm has a growing point which develops either more nodes and leaves or seed heads. Grass leaves have several parts. The blade originates from a node, which is where the cells divide and become larger. The sheath extends and pushes the leaf out of the tube. Once the leaf has emerged and unrolled or unfolded, its growth is complete.

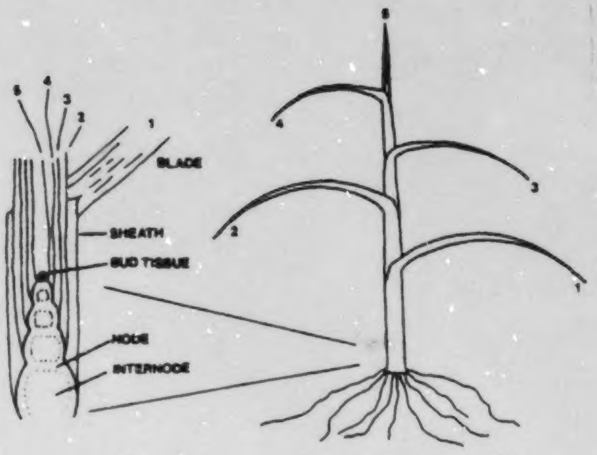


Figure 3. Anatomy of a grass stem.

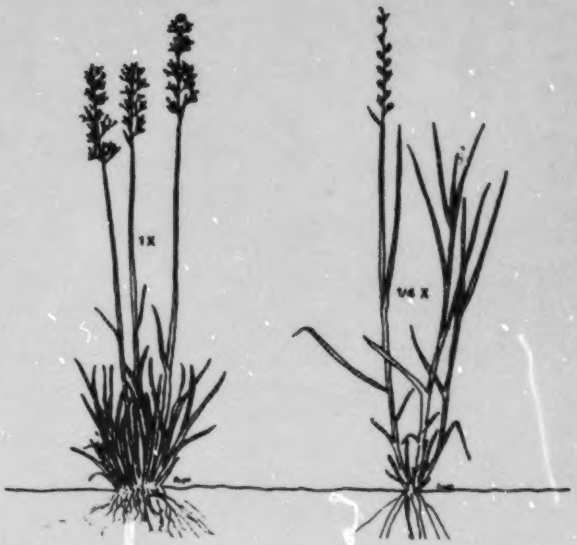


Figure 4. Examples of a stemless grass, Kentucky bluegrass (left), and a stemmed grass, bluebunch wheatgrass (right).

Grasses are of two common growth forms--stemmed and stemless. Stemmed grasses tend to have a high percentage of reproductive to vegetative stems (Figure 4). Some stemless species also have a high reproductive-vegetative ratio, but several, such as the bluegrass and grama grasses, have a high ratio of vegetative-to-reproductive stems. Stemmed grasses tend to be more robust and productive. They also are more numerous in the cool season growing conditions. Some species have the ability to grow more or less prostrate and can escape grazing that way. Management to incorporate this knowledge will allow you to capitalize on each plant species' desirable and less desirable points.

Stemless grasses are less susceptible to grazing than are stemmed grasses. Their growing points are at or below ground level for most of the growing season and their leaves are pushed up through the tube from below ground. The nodes are close together; only in the later part of the growing period do the upper internodes elongate so a mature grass appears with mostly basal leaves and relatively few seed stalks. In stemmed grasses, the early leaves up through 4 or 5 are pushed up as with stemless. Then, the internodes start to elongate and soon the growing point is lifted, whether it produces seed or not.

If the growing point is removed, there will be no more growth on that stem. That cannot happen for the stemless ones because the growing point is too low to be grazed. For the stemmed group, all new growth will have to come from inactive buds at the base of the grass. If sufficient soil moisture exists, such buds may develop, but in most years there is not enough soil moisture left for very much regrowth. If grazing can be managed intensively enough, this factor can be capitalized upon, e.g., crested wheatgrass may be grazed heavily enough so its growing point will be removed. After this time, most new growth will be vegetative.

By knowing your major grasses and how they grow, you will be able to set the most advantageous time to graze each area. You will also be able to predict the level of use the plants will tolerate and still produce well.

E. Developing Management Strategies for Your Range

This guide is designed to cover topics that range cow-calf producers will face as they develop management strategies for their overall operations. Two underlying assumptions were made. First, that spring calving is the common practice, and second, that hay would be made and used for winter feeding. When producers do neither of these practices, the parts addressed to those topics do not affect them.

The guide is composed of a yearly calendar of management events or activities and a management planning section. The planning section is first because it sets the stage for those events in the yearly calendar.

1. Management Planning

Every producer makes plans, whether formalized or not. Many plan over a more or less continuous time throughout the year. This is good. Designating one central time of year for planning has some merits as well. These are addressed in this section and offered as a logical way to plan the range and hay parts of an overall production program.

Major planning can be done at any time of year but late fall to early winter is suggested, for two reasons. The experiences of the previous season are fresh and can better be brought to bear. If any "slack" time exists during the year, it should be then.

a. Review Year Just Completed

Analyze your notes and records carefully. Then answer these questions:

1) How well did you meet all of the objectives that you had planned?
2) What kind of a range forage year was it? How was it different in terms of both weather and the effect that weather had on the amount, time, and quality of forage growth?
3) How well did the forage supply and demand work out? Were you short or long on forage? If short, what could you have done differently to avoid the shortage? If long, what were the reasons? Could or should you have done anything to use more forage?
4) What adjustments did you make from your plan? Were they effective in meeting your objectives?
5) To what extent did weather positively or negatively affect plant and animal production as compared to your direct management? In other words, is your management having positive effects?

b. Review Your Long-Range Ranch Plan

1) Is it still viable? Are the goals realistic as you build your record base? Discard or revise the impractical or unachievable goals.

c. Set Objectives for the Coming Year

1) Consider tax management and lending/borrowing policies. They can greatly affect objectives.
2) Break objectives into sub-objectives and develop procedures to meet each. Be sure to consider all feasible, economical alternatives.
3) Make objectives both realistic and limited. For example, the objective in pasture A may be a total of 500 animal months of grazing based on forage potential. Let's say you currently produce 300 animal months. To get to 500 animal months may take several changes, e.g., more stockwater and grazing adjustments in both time and number. So, set something less than 500 for this year, perhaps 350 or 400. Try to achieve it by a change in the pattern of grazing use, perhaps through another water development or a change in salting patterns.

d. Develop Grazing Plans and Schedules

   1) Based on forage production and utilization data or observations, determine where grazing management changes would be beneficial.
   2) Determine what improvements in the coming year would be needed to put those changes into effect.
   3) Build in necessary flexibility to accommodate a poor forage year or like condition.

e. Review Plans for Range Improvements

   1) Is your range improvement schedule being met? If not, should the schedule be modified?
   2) Are improvements meeting your production expectations? Let's say you seeded a new pasture with crested wheatgrass. Are your cows breeding back faster and in more numbers since your new seeding has been used as a breeding unit?
   3) Are they giving your operation the management flexibility intended?
   4) Review maintenance schedule for fences, water developments, roads, etc.

f. Adjustments in Livestock Numbers

   1) Is your forage and range management permitting increases in numbers? If so, advance plans must be made on when and how to purchase, what classes to purchase, and how many to purchase.
   2) Maintain proper seasonal balance of feed supply and animal demand.
   3) Apprise your lender of money needs well in advance.
   4) If you plan to put part of your ranch in a non-use category to permit range improvements, temporary livestock reductions may be necessary.

g. Leased Forage

   1) Review grazing leases, including public land licenses and permits. Are provisions satisfactory and, if not, what changes are necessary?
   2) Determine the security of forage sources.

3) Examine alternative forage sources
4) If animal grazing changes (e.g., times and numbers) are contemplated and you have a public land grazing permit or license, be certain you coordinate with public land administrators.

h. Hay Production

1) Review overall hay management program. For example, be certain the kind and amount of fertilizer used is paying its way. Order supplies well in advance of need.

2. Calendar of Management Activities

This is intended to be a reminder of major considerations, not a list of things to do. Keep a record of your own activities and modify those in this calendar as they fit your operation. It is very important to keep a daily diary/notebook. With information on how many cattle were put into and taken from pastures on certain dates, a continuous overall use record can be made. Record notes made on utilization checks. The information you record will be quite useful each winter when you review management plans for the coming year.

a. Winter

Range plants generally will be dormant and main management concerns will be for livestock health and well-being. For livestock that are wintering out, make certain ample forage is available for selection, since nutritive values may be at their yearly low. Cattle with access to palatable shrubs in addition to grasses will be better able to meet their needs than on grasses alone.

1) Dormant perennial grasses and forbs should not be damaged by levels of use up to perhaps 90 percent. More damage can occur from physical effects than from defoliation.
2) Annual plants will normally be dead so removal will not be damaging. Fall germinated annuals will be too short to provide adequate forage for more than subsistence.
3) Removing more than about 75 percent of current twigs will be detrimental to most shrubs. Some energy for maintenance of plant health is stored in twigs.

b. Spring

1) Record the date each species starts to grow. This will aid in projecting when ranges will be safe to begin spring grazing that year. Build an initiation-of-growth record over several years. You will find it helpful in long-range planning.
2) Monitor relative development rates of forage plants. This should aid in assessing whether adjustments in grazing plans will be necessary.
3) Use crested wheatgrass for first spring pastures, when available. This allows deferring use of native pastures. Crested wheatgrass will be more dependable than native species in providing forage at that time. Cows will receive a flushing effect from crested wheatgrass. Stock at 3 to 4 acres per animal-unit-month (AUM) during early season and 1 to 2 acres/AUM during late spring on full stands in healthy status, as an example.
4) Use rough country with yearlings rather than cows and calves if that option is available. Yearlings will cover country better and make more efficient forage use. Weigh yearlings before turning them out so you can determine their performance from range forage.
5) Fertilize hay meadows. Leave a check strip so you can determine relative value of fertilizing.
6) Assess effects, if any, of winter big game use on spring forage supply. Quantifying the impacts will be necessary if justifiable cases are to be made for reducing the wildlife impacts.

c. Summer

1) Coordinate federally leased forage activities with appropriate range conservationist. Make sure that communication channels are clear and no misunderstandings occur.
2) Record the kind of a forage year by range unit.

3) Record degree of grazing utilization by date. Are your grazing objectives being met? Degree of grazing use on a particular date will vary. For example, in a good forage year, amount of use will be much less unless stocking rate was increased to make up the difference. Total utilization and where it occurs should reflect true situation.
4) Record the actual grazing use so overall grazing capacity can be determined. Combined with trend in range condition, actual use information can be useful in assessing whether target grazing capacities are realistic.
5) Record hay production by field. Also record species composition and expected feeding quality.
6) Record conditions for hay making.
7) Determine value of fertilizing by comparing production in check strips against the remainder of the fertilized unit.

d. Fall

1) Determine animal production:

    a) Weights of yearlings and gains on range and/or pasture
    b) Weights of weaned calves

2) Determine percent pregnancy of your cattle. Was there a positive relationship between feed conditions during breeding time and percent pregnancy?
3) Make an overall utilization map for all grazed pastures. Use the information that has been developed previously during the season. Use the map in planning for the next year.
4) Assess degree of seedling establishment for new range seedings. Are they well rooted? When can grazing be safely scheduled?
5) Take soil samples from meadows and other areas you want to fertilize to determine specific nutrient needs.

e. Continuous Management Activities

1) Monitor grazing activities--make sure grazing plans work right. Use salt and water to distribute grazing. Move a fence location if it will help.

2) Watch for incidence of poisonous plants.
3) Make utilization checks. Build up information base so you can make better overall use in future years.
4) Don't be reluctant to ask your county Extension agent or Soil Conservation Service representative for help. Their jobs are to serve you.

F. Range Nutrition in Relation to Management

Matching the nutrient demands of livestock and the nutrients supplied by range forage comprises a real balancing act for a considerable portion of each year. Operators should know the basic needs of their stock at any one time during the production cycle. However, the changes in nutritional status of the animal's diet from day to day as the season progresses is not so well known. Because range forage nutritional values vary so greatly from one location to another, only examples of nutrient amounts and trends will be used. Whenever possible, general principles of production in relation to nutrient availability will be stressed.

1. Nutritional Value

Levels of plant nutrients are reported as chemical composition and apparent digestibility percentages, that is, concentrations in the plant material. Numerous ways of expressing nutritional values have been developed. Most of the time, reasearch must use indirect methods of one kind or another when dealing with range and pasture forages. Consequently, a good deal of estimation of value is done.

For a plant to have value it must be selected and grazed by the animals and it must contribute substantially to the digestible nutrients of the diet. Therefore, selectivity by grazing animals is important in determining value of the plant species on a particular range. It is possible to minimize the effects of selective grazing by forcing or stimulating uniform use at particular seasons. Animals may not perform quite as well when use is forced.

The rumen bacteria are responsible for digestion and they may not be as "fussy" as the animal's taste buds. Therefore, performance could be better than expected if you can get the animals to graze the plants available. Unpalatable plants do not necessarily have poor nutritive value but their forage value is because they generally are not selected. Some plants, such as milk vetches and lupines, have both high nutritive value and are palatable, yet are harmful to cattle.

The species composition on the range has a great bearing on the forage value obtained from it. Figures 1, 2 and 3 show seasonal crude protein and moisture contents and apparent drymatter digestibility of several important forage species from south-central Oregon shrub-grass ranges. Note that the crude protein levels of the grasses are often in excess of 20 percent at the start of growth in spring but decline at different rates to 5 percent or less by the end of the season. Although not shown, seasonal trends with forbs (herbaceous plants other than grasses) are similar, although protein levels of legumes are higher than grasses in mid to late season. However, the leaves of forbs, where nutrients are often concentrated, shatter when the plant dries. This then renders nutrients unavailable.

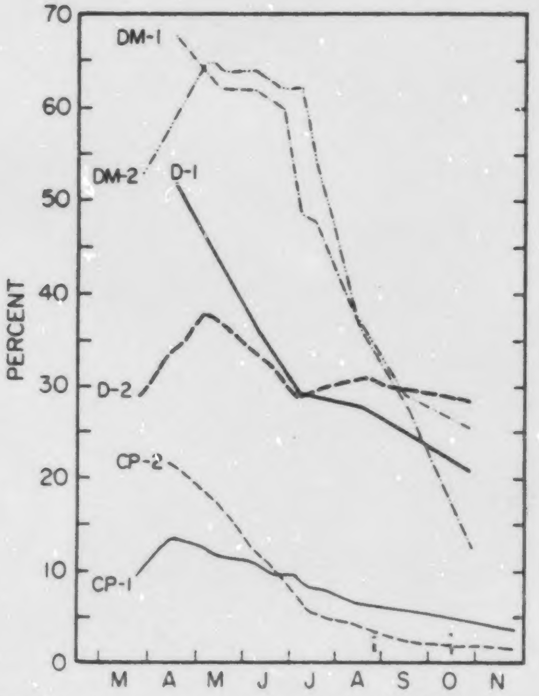


Figure 1. Seasonal trends in crude protein (CP), apparent digestibility (D), and dry matter (DM) of bluebunch wheatgrass (1) and Idaho fescue (2) in south-central Oregon.

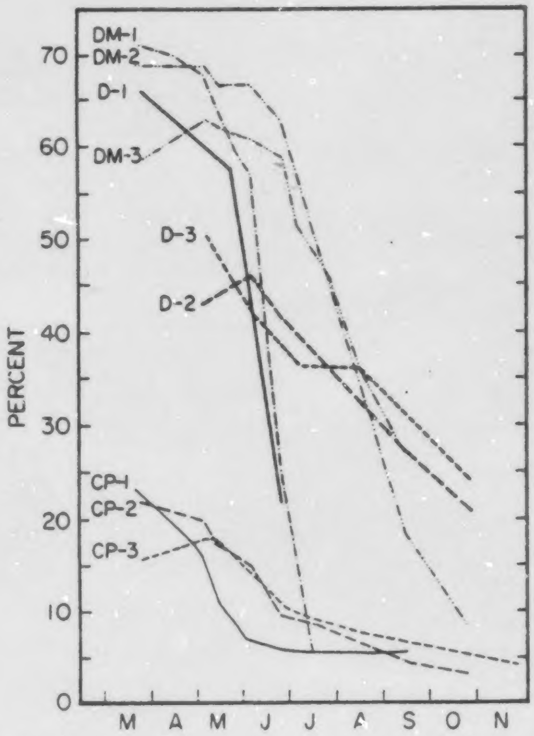


Figure 2. Seasonal trends in crude protein (CP), apparent digestibility (D), and dry matter (DM) of Sandberg bluegrass (1), squirreltail (2), and Thurber needlegrass (3).

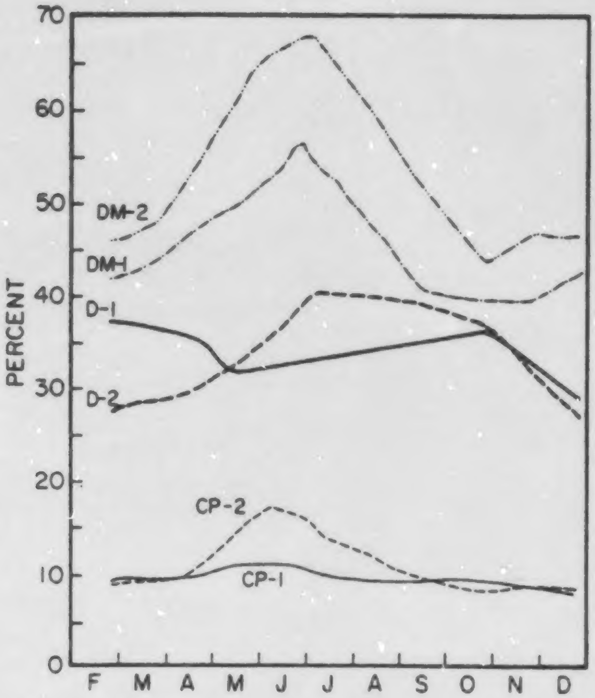


Figure 3. Seasonal trends in crude protein (CP), apparent digestibility (D), and dry matter (DM) of western mountain mahogany (1) and bitterbrush (2).

Note that seasonal trends in nutritional values for the shrubs differ greatly from grasses. Producers whose cattle utilize browse ranges will recognize from experience why performance can be reasonably high into late season. Note that crude protein in shrubs stabilizes at levels around 10 percent in the fall and winter, whereas that of grasses is less than 5 percent. However, if the shrubs are not palatable and will not be grazed at all, cattle will need to subsist entirely on mature grasses and forbs, which will be low in digestible protein and energy. Research shows that nutritive value differences between species within a single year are as great as the difference between years. Consequently, it is nearly impossible to predict accurately the nutritive values at particular times in the growing season without knowing what kind of growing season will exist. Figure 4, illustrating a composite of several Oregon high-desert grasses over several years, shows insufficient protein content after early July to sustain high levels of performance.

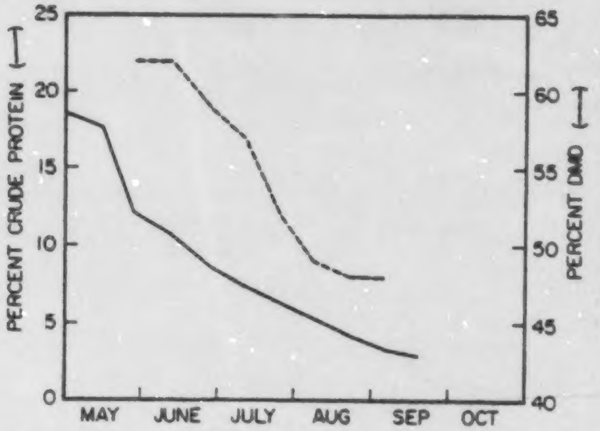


Figure 4. Seasonal declines in percent crude protein and dry matter digestibility of perennial bunchgrasses in the Oregon high desert.

2. Digestive Physiology

The ruminant can survive, grow, and reproduce on forage alone because of the bacteria and protozoa contained in the rumen section of the stomach. These microbes have the ability to use the chemicals found in forages for their own growth and reproduction. Microbes, in essence, digest the food the animal eats. As this occurs, certain synthesis actions take place, including sythesis of all of the B vitamins and of the amino acids from nitrogenous compounds (protein) in the food. In a sense, the microbes can make a complete diet out of what would otherwise appear to be only a partial diet. Then, as microbes die, their body products are absorbed by the animals for their basic nutrient needs. In reality, we provide a diet which satisfies the rumen microbes and if they are satisfied, the animal is satisfied.

Levels of most nutritive components decline as a plant matures, regardless of species. Protein in the diet can become limiting before energy does for young cattle and lactating cows. This is one of the main reasons why performance of these classes of cattle declines sharply when the forage matures. Cattle tend to select diets that are higher in protein and lower in fiber than that contained in the total available forage when it is growing. After plant maturity, selectivity may increase, but several research studies show dietary values and values of the mature plant to be more similar than different.

The animal must be able to consume enough forage to meet its needs. Amount of forage intake is especially important early in the plant's growth period. Studies show that the amount of moisture can limit the amount of total dry matter intake but the moisture content in itself should not affect the level of gain. Research at the Squaw Butte Experiment Range in eastern Oregon shows that gains of yearlings on forage alone were as high from early May to early July as they were when either protein or energy supplements were given. Both before and after these stages some deficiences usually exist, although supplementation programs are designed to compensate for this. Protein quality (the composition of amino acids) is not important for the ruminant, but the total amount of crude protein or nitrogen-containing material is important. Ruminants synthesize their protein needs from the nitrogen. In fact, non-protein nitorgen sources, such as urea, are commonly used in protein supplements. The supply of digestible carbohydrates must be above a certain minimum level for this to occur successfully, or the animal could suffer from acidosis or from too much ammonia released within the system.

After the time of optimum combinations of nutrients occur in the forage, the manager has the option of moving stock to areas of less mature plants, of supplementing that forage, or of modifying the demand, as in weaning the calves to taking off yearlings. Often, forage value differences may occur within a fairly short geographical distance. For example, species mature later on cool slopes and at higher elevations. Grazing these at later dates is commonly done to extend the season of acceptable forage value.

Comparison of the curves in Figures 5 and 6 shows that protein becomes deficient before energy does on sagebrush-bunchgrass ranges. Based on those nutritional relationships and the fact that calves gained less than 1 pound daily after September 1, research at Oregon's Squaw Butte Agricultural Experiment Station suggests weaning spring-born calves in September. Keeping calves on their dams, compared to weaning and putting on grass hay without limit, but with a daily ration of 2 pounds barley and 1 pound cottonseed meal, resulted in less than one-half the daily gain. Post-weaning shock was greater for the normally weaned calves (late October) and this resulted in a daily gain of only .6 pound for the next 35 days, as compared to 1.5 pounds for those early weaned.

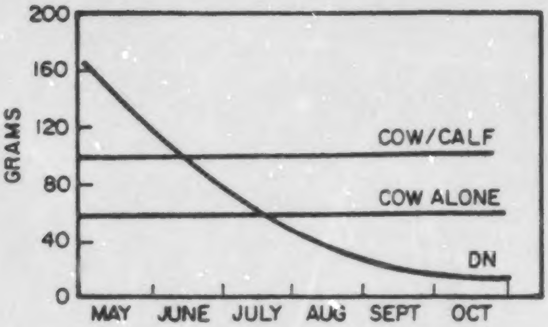


Figure 5. Amount of digestible nitrogen required by cows with calves and dry cows and the amount they will get from the range forage.

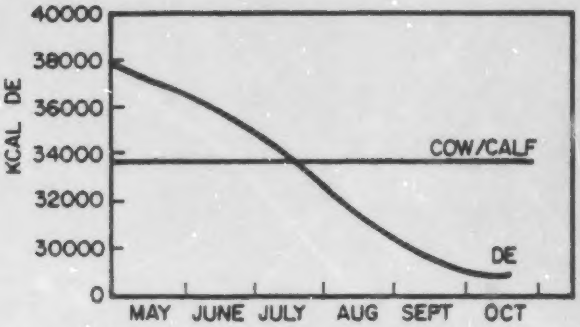


Figure 6. Amount of digestible energy required by cows with calves and the amount they will get from the range forage.

Early weaning does not work the same under all range forage conditions. Where forage quality in the fall is sufficient for cows to continue milking, calf gains should be as high as when weaned and fed. Such forage conditions might be those on ranges with palatable browse, where use was deferred until fall, where regrowth of seeded species such as crested wheatgrass, Russian wildrye, or intermediate wheatgrass are available, or where irrigated pastures or meadow aftermath exists.

Time of calving can be keyed to range forage conditions better at some seasons than others. Most calves are spring-dropped. Under poor summer and fall range conditions, but good spring feed conditions where winter feeding is practiced anyway, some advantages exist to fall calving, as regards use of range forage. With an October calf weighing about 300 pounds in April, maximum efficient use can be made of spring forage, since forage values will be adequate for good milk production and calves are old enough to utilize the forage. Weaning can occur in early July and the dry, pregnant cow turned back to range that is adequate for her needs until she is nearly ready to calve.

Conversely, studies also show that when forage values remain high from May to October, spring or winter calving will allow efficient forage use without having to feed too heavily or too long during winter.

Advantages and disadvantages can be cited for different times of calving, but fitting the production demand pattern of the cattle to the supply available forage will be the key to the problem.

Supplementing range forage still is not common practice, but there are times when it makes good sense. Supplementing does not mean substituting purchased feed for range forage. It means making up the difference in quality between what range forage provides and what cattle need. In order to do this successfully, the producer needs to know what nutrients are deficient, how deficient they are, and what alternative feeds are economic to accomplish successful supplementation. Supplements may be primarily of a protein nature, of an energy nature, or of a mineral nature. So much variation exsits in the use for supplements that is it impossible to mention all of the needs for them.

Dry forage often is supplemented with some form of protein. Adding nitrogen or protein to the diet stimulates the rumen microbes to digest fibrous material more effectively; this causes a more rapid rate of passage, the animal eats more range forage, and performs better. Liquid forms in a molasses base, with added phosphoric acid, often are used, so some energy is included.

On lush, spring pastures, small daily increments of grain have given effective results in Colorado and Oregon studies. On wet, high-protein grass, a high urinary protein loss can occur. Provision of supplemental energy helps to counteract this. After crude protein content of forage declines to below requirements, these studies showed that addition of small quantities of protein, in addition to energy, would promote effective forage use and keep up performance. No supplements would be needed during the May-July period, however. This kind of program would be suited to an operation that did not have good summer range. Yearling heifers could be grown out well and should breed well, yearling steers would gain well and first calf heifers would be able to make continued growth, milk, and breed back on time.

G. Poisonous Plants and Range Management Alternatives

Hundreds of plants contain properties that at one time or another can be harmful to farm animals. Many of these plants occur on western ranges. Direct economic losses to cattle producers from poisonous plants were estimated to be $91.3 million in 1978. Poisonous plants cause indirect losses also, such as reduced animal performance, reducing the optimum level of resource use, and increasing costs of management. Often considered an animal health problem, beef producers will be better able to prevent and/or reduce losses if poisonous plants are thought of as a range management subject.

1. What They Are--Where They Grow

A poisonous plant is one that contains a toxic substance that can cause detriment to health or even death of the animals that eat it. Noxious plants are usually classified as unwanted and undesirable, nonpoisonous plants. Some plants irritate parts of the body but are nonpoisonous. Whether an animal just gets sick or gets sick and dies depends on the characteristics of the toxin, the dose, and the time over which the dose was received. In some cases abortions or deformed offspring may result. Many poisonous plants are not palatable and will not be consumed when the area is properly stocked with other forage plants. The concentration of the toxic substance often declines as the plant matures and the plants tend to be early season growers which decreases their relative abundance as the growing season advances. However, there are exceptions.

Plants that contain toxic or poisonous principles are natural components of the vegetation on many rangelands. Their relative amount depends on the ecological status of the species and the past use of the range. They can be part of the climax plant community, as with the larkspurs, or they can be found only in low ecological condition situations, as with arrowgrass. Poisonous plants tend to be much more abundant on poor to fair condition ranges than on good to excellent condition ones.

2. Management to Reduce or Prevent Problems

To prevent losses the producer must know:

a) The plant ecology on the ranges
b) The identity of poisonous plants and where they occur
c) How a species affects livestock
d) When the plants are most poisonous

Poisonous plant problems will be minimized if a producer stays aware of the fact that good range management means:

a. Proper stocking rate
b. Grazing at times when plant productivity will be least affected
c. Distributing grazing pressure evenly
d. Using the proper kind and class of livestock

Graze to maintain or improve range condition. Even if poisonous plants are present, there should be more other forage available to allow stock to be selective enough to avoid the harmful plants. Treatment of affected animals is often too late. Be aware that seasonal and site differences can expose stock to abnormal populations of some plants. This is why knowledge of plant identity is so important.

3. Management Considerations

a. Do not graze beyond the grazing capacity. Overgrazed ranges can mean increased proportions of poisonous plants, because more preferred species have been removed or because preferred plants are so low in production that livestock must graze the less preferred ones.
b. Do not graze too early in the season. Let the desired forage plants get a good start before turnout. Often, early growing poisonous plants such as low larkspur and death camas are the first to turn green.
c. Do not turn hungry stock onto infested ranges. Normally stock are selective grazers, but when hungry, they tend to eat whatever is within reach.
d. Move stock carefully through infested areas. Also, don't crowd too much. Crowded animals consume anything they can, just as hungry ones do. Stock should have full stomachs before being trailed.
e. Take care about turning animals onto an unfamiliar area, especially one which may contain some poisonous plants. Such stock may be less selective in their grazing.
f. Make certain stock have free access to salt, phosphorous, and other needed elements. Move salting locations to aid grazing distribution. Moving locations can serve to lure stock from poisonous plant areas. Be sure to move the cattle so they know the new locations.

g. Adequate water is extremely important. Also, if water is near poisonous plant areas, consider fencing stock from it so they will not be attracted there during the high-susceptibility season.
h. Do not make hay from areas with poisonous plants. Plants such as arrowgrass commonly grow in areas that could be hayed. Stock do not eat hay selectively so would get more of the poisonous plant than they might if the same area were grazed.
i. Do not graze when poisonous plants are the most dangerous. Try to develop management strategies to avoid or minimize the possibility of grazing at the worst time.
j. Use another kind or class of stock if that will help. Larkspur-infested ranges can be grazed safely by sheep.
k. Be cognizant of special environmental conditions that will either restrict animal movement or forage availability. Examples are:

   1) Drought. Take special care during drought, as poisonous plants could make up a higher proportion of forage and would be more attractive than normal.
   2) Unseasonal snow conditions. These may restrict the diet to undesirable, perhaps poisonous species.
   3) Extremely wet conditions. These can bring out higher levels of toxicity in some plants or perhaps the tubers or roots will be pulled up when grazing. Tubers and roots often contain the highest concentration of toxin.

4. Control of Poisonous Plants

When livestock management changes are not possible to make or would not be of benefit, it may be possible to control the plant through chemical or mechanical means. Some species lend themselves to this very well, whereas, others do not. First, learn the ecology so as to predict the results of removing the plant on the total plant community. The plants you remove should be replaced with more desirable plants, since nature will not leave a vacuum. Only after it is determined that control is feasible should chemicals be used. Examples of successful control vary. Low larkspur, fortunately, can be controlled by 2,4-D ester at normal sagebrush spray rates and at the same time. Conversely, chemical control of tall larkspur is more difficult and must be repeated.

5. Examples of Plants Poisonous to Cattle

a. Arrowgrass. Grass-like. Perennial. 1 to 3 feet tall. Found in wet areas, often in rush-sedge hayed meadows. Often in saline-alkaline areas. Contains hydrocyanic acid. Lethal dose is 0.1 to 0.5 percent body weight, consumed in a period of an hour or so. Poisonous in both green state and in hay. Much worse when stressed by moisture shortage or frost. Management: Do not graze infested areas when arrowgrass has been drought or frost stressed. If in hay, feed with good hay to dilute the arrowgrass.

b. Low Larkspurs. Several species poisonous. Low-growing perennial forbs. Generally 6 to 24 inches tall. Depending upon species, found on grass or shrub-grass ranges in plains, dry meadows, and foothills. Contains alkaloids. Lethal dose is 0.5 to 3.0 percent body weight. One of the earliest growing plants on spring ranges. Young growth is most poisonous. Palatable. Matures early. Sheep not affected. Management:

1) Graze with sheep during early part of season
2) Delay cattle use until larkspur has flowered
3) Control with 2 pounds 2,4-D ester per acre in early growth stage

c. Tall Larkspurs. Large, erect, perennial forbs. 3 to 7 feet tall. Grow in areas shaded by trees or tall shrubs in mountains. Often with aspen. Mostly occurs in patches. Contains alkaloids. Lethal dose is 0.5 to 3.0 percent of body weight. Relatively late maturing. Poisonous at all times, although least at maturity except for seeds. Palatable. Management:

1) Spot chemical control or hand grubbing often only feasible approach
2) Graze with sheep
3) Delay grazing with cattle
4) Fence out worst areas

d. Water Hemlock. Stout, erect, perennial forb with tuberous, thickened roots. Small white flowers on an umbrella-like cluster. Leaves divided into two or three leaflets with saw-toothed edges. Grows along streams, ditches, and in swampy areas. Roots must be in water or wet soil. Extremely poisonous to all animals including man. Walnut-sized piece of root stock will kill a cow. Early growth of leaves and stems and the roots are the most poisonous. Management:

1) Grub out plants. Be sure to remove tubers
2) Delay use until preferred forage available
3) Chemicals effective but may have to be reapplied

e. Poison Hemlock. Erect biennial (sometimes perennial) forb. 2 to 10 feet tall. Stems branched, hollow, and purple-spotted. Leaves finely divided. More so than water hemlock. Leaf veins terminate at tips of leaf teeth; those on water hemlock terminate between leaf teeth. Flowers are like water hemlock. When foliage is crushed, it has offensive odor and taste, parsnip or mouse-like. Found in damp areas not as wet as for water hemlock. Contains at least five alkaloids. Lethal dose is 0.1 to 0.5 percent body weight of green material. Not palatable, but if no other available forage, cattle will graze it since it grows early in spring. Management: Delay turnout until adequate amounts of preferred forage are available.

f. Milkvetches. Milkvetch, poison vetch, locoweeds (Astragalus spp.). Low-growing perennial forb in the pea family. Flowers white to purple on leafy stems. Not all species poisonous. Found on dry plains and slopes, generally, but one species, timber milkvetch, grows in better sites, often in open forested conditions. Three main kinds of situations:

1) Milkvetches, poison vetches that accumulate selenium, causing both acute or chronic poisoning
2) Locoweeds, causing locoism or affect the animals' judgment. Generally chronic poisoning
3) Timber milkvetch, containing nitro compounds that cause acute or chronic poisoning

Selenium-containing milkvetches or poison vetches are usually not palatable, but do convert selenium into compounds readily absorbed by associated, preferred, forage species from the soil. Thus, cattle can be poisoned by grazing plants within their normal dietary preferences. Locoweeds: cattle normally will not prefer them, but once grazed, they will become addicted. The effects are cumulative. Timber milkvetch is palatable, with as little as 2 pounds of green material fatal to a cow. Management: Chemicals may be effective but distribution is often too sparse to warrant their use. Provision of adequate preferred forage through good grazing management is best alternative.

g. Prince's Plume. Selenium-containing, coarse, many-branched, yellow-flowered, perennial forb. Found on relatively dry sites in soil high in selenium. Poisoning may be either acute or chronic. Quite unpalatable. Not widespread in occurrence.

h. Point Locos or Point Vetchs. (Oxytropis spp.). Often confused with Astragalus locoweeds. Are low-growing perennial forbs, with white to purple flowers on leaflet stems. Oxytropis has keel (lower most) petals narrowed in beak-like points; whereas, Astragalus has rounded keel petals. Not all Oxytropis species are poisonous. Found mostly on open plains and grasslands. Causes same loco problems as Astragalus species.

i. Lupines. Many species on western ranges: Most are not poisonous. Effects on cattle are teratogenic (congenital deformities), although direct poisoning from alkaloids does occur rarely. Three main teratogenic-causing species: silky (Lupinus sericeus), tailcup (L. caudatus), spur (L. Laxiflorus). Erect, perennial forb, 5 to 7 finger-like leaflets, flowers white, pink, yellow, or blue and white. Found in moist but well-drained sites. Widespread. Pregnant cows that eat as little as 1½ pounds per day when in the 40th to 70th day of gestation have produced "crooked calves." Alkaloid con entration is quite high at early growth stages, but declines markedly as the plant matures. Mature seeds contain high concentrations, however. Management: Avoid grazing infested areas when cows are in 40th to 70th day of gestation, when lupine is in pre-flower stages, and when seed is ripe.

j. Chokecherry. Shrub or small tree up to 30 feet tall. Oval, pointed tip, dark green leaves. Yellow-white flowers in dense clusters. Found mostly on seasonally moist sites in valley bottoms and hill sides. Contains hydrocyanic acid. As little as 0.25 percent of body weight as fresh green leaves is lethal if consumed in a period of an hour or less. Drinking water intensifies the reaction. Toxicity declines as the plant matures. Not very palatable. Main problem in early spring before adequate preferred forage available. Best to avoid grazing chokecherry areas at this time.

6. Plants That May Cause Occasional Problems

   a. St. Johnswort, Goatweed, Klamath Weed. Yellow-flowered perennial forb, 1 to 3 feet tall. Leaves with small dots. Found mostly in disturbed areas. Causes photosynthetization, so affects light-skinned cattle. Unpalatable. Generally not fatal but causes seriously decreased performance. Easily controlled biologically with an adapted beetle.

   b. Bracken Fern. Unpalatable. Problems more commonly occur if in hay. Widespread on more moist but well-drained sites. Cumulative effect. Cattle must consume an amount equal to their body weight over a 1- to 4-month period to be fatal.

   c. Death Camas. Perennial, basal leafed herb with onionlike bulb and white to yellow flowers. Mainly a problem for sheep. Grows early in spring. Contains alkaloids. Relatively unpalatable.

   d. Milkweeds. Several species. Mostly affects sheep, but cattle are susceptible. Large forbs usually with milky juice. Occupies many habitats. Very unpalatable. Most poisonous when green, but retains toxicity even when dry.

   e. Ponderosa Pine. Causes pine needle abortion. Cows may die as well as abort the fetus. Avoid exposing pregnant cows to fresh available pine needles.

   f. Greasewood. Contains oxalate. Not a problem unless no other forage available. Considered good forage as long as mixed in the diet. Oxalate content increases with plant age, but palatability declines, so spring period is most hazardous.

Almost every state has a good publication on poisonous plants. One of the best is "Poisonous Range Plants of Montana," Bulletin 348, June 1977, available for $1.95 from Montana State University, Bozeman, 59715.

H. Range Management--Dealing with Drought

Regardless of how drought is defined, dealing with it is an extremely serious proposition. Drought can occur as growing season dryness, winter drought, or both. In the Intermountain West, drought occurs one out of every four or five years. If drought is not planned for, the beef operation may not survive. Even when it is planned for, serious adjustments must be made.

To manage successfully in the face of drought the producer needs to know how drought affects plants, cattle, and their management, and what options exist to avoid the extreme consequences of both ruining the range and selling the cattle.

1. Effects on Plants

Forage production is decreased dramatically. Plants with shallow roots are effected much more than deeper-rooted ones. Annual plant production may be practically non-existent. High ecological condition ranges will be less seriously affected.

Perennials will have to be dormant for longer periods than normal. Very little is known about the plant's ability to store carbohydrates under abnormally dry growing conditions. It is possible that no carbohydrates are stored at all, but that really is not known for a fact. To insure the greatest potential for health, plants probably should receive as light a grazing pressure as possible and practical during their growing season.

Roots make up 50 to 80 percent of most range plants. If any deep soil moisture exists at all a healthy, deep-rooted plant may be able to get it. Roots cannot penetrate dry soil to get at deeper moisture.

The length of drought has a large bearing on plant health. Perennials continue to respire while dormant, so the size of their energy reserves is even more important than normally. When drought continues for more than 1 year, plants may begin to break up. As the plant community opens, it becomes more susceptible to invasion by annuals and lower-value palnts. When droughts are severe over a period of years this could happen even with light or no grazing.

Ability of perennials to recover following drought seems to be closely related to the degree of grazing pressure existing before and during drought. Utilization that exceeds 60 percent of current growth can decrease some plant species' ability to recover, according to a recent study in Oregon. However, light use (not above 25 percent) seemed to have a beneficial effect. Moderate use (25 to 60 percent) seemed not to affect production of several major species. The degree of use seems to affect the plant's ability to initiate growth after drought, as early growth was slower on moderately and heavily grazed plants as compared to lightly grazed to ungrazed ones.

Nutritive values of individual plants during and shortly following a shortened and dry growing season actually may be higher than normal, since there is no dilution effect of nutrients by much top growth. But, the subsequent dry season often is longer than normal, and deterioration of forage value probably will occur at the same rate as a normal year. This results in less overall forage value, although more as a result of lowered quantity than lowered quality.

2. Effects on Cattle and Management

Unless stocking pressures are reduced in accordance with forage availability, weaning weights may be reduced seriously. Research shows near normal weights when stocked in relation to reduced forage supply. Having enough stock water will aid a cow in lactation. Since lack of water often is as serious as lack of feed, some weaning weight reduction may have to be tolerated.

Upsetting the cows' ability to breed on time seriously affects future production. When cows do not get adequate nutrition during lactation, they respond by missing heat periods or, at best, will breed but not conceive. Drought in the period following calving and remaining through several months can delay a cows' breeding for 3 months or longer. Special provisions can be made to provide cows with good feed to keep them on schedule. If not, a producer is looking to several years of reduced production from cows who breed late and thus calve late the following year. Late calves are always lighter. A cow that calves 3 months late, even if she could be managed to breed back one cycle early per year (not probable) would take at least 4 years to get back on schedule. If cows had 4 or more years of productive life remaining, producers should consider skipping a year to get back on schedule.

During drought, normal water supplier such as reservoirs and ponds may not be available. Couples with less stream and spring flow this will result in inadequate animal distribution and lowered performance and condition. Although unused forage may be present in the farthest reaches of pastures, the probability of harvesting it is questionable.

3. Management Options

Before you can look at options, you must have a clear picture of all available resources. Inventory your own available feed supply and where it occurs. Assess alternative feed suppliers, their availability, and cost. Evaluate your livestock inventory.

Droughts mean reduced stock number. If you have to sell, keep only healthy, early to mid-aged, productive cows. Cull out the late calvers, regardless of age. Keep fewer replacements.

Determine if you have any viable possibilities of developing more water or if additional fencing will be required, even temporarily, to make better use of your range feed. Taking action at the beginning of a drought can be critically important later. Options will depend on levels of past grazing use. Animal adjustments will be necessary regardless of the option, unless there is a real abundance of unused available forage.

a. Light-Moderate History

Reduce grazing load to match forage supply. Continue light to moderate use which will allow plants to maintain their present level of vigor.

b. Heavy Grazing Use History

Defer use if at all possible. Range plants probably have reduced root systems and they need to make as much growth as possible. Light grazing following dormancy then could occur. You can't defer use if you do not have alternate feed.

If you do not have any feed alternatives your options are fewer:

1) Reduce numbers as much as you possibly can, at least for early season grazing
2) Spread grazing load uniformly. A plant should only be grazed one time. There will be little opportunity for regrowth if grazed repeatedly.
3) Stock water will be a real problem. Graze the areas first where the water source may fall in later season. Haul water, if necessary, but prepare for high costs. Drinking on alternate days will not lower production of dry cows and yearlings but a lactating cow needs water daily or calf gains will be reduced by one-half or more. Lactating cows drink 15 gallons per day in summer.
4) Supplement low-quality feed. Do not substitute feed. If supplemented, cattle should rustle for themselves better; if substituted they will not. Do not let the cattle condition serve as an index of range utilization. Animal performance can remain stable, even improve while the range is being hurt.
5) Wean early and feed at home, at another feedlot, or sell. Calf performance will stay up. Cows won't get as poor, or if poor won't stay as poor. If in extreme drought, calves can be weaned early and treated as dairy calves are. This will be better than suffering both poor calf and cow performance.

If you have alternate feed, consider:

6) Grazing annuals heavily. Production from annuals may not be much but they can be grazed heavily and still reproduce.
7) Graze crested wheatgrass, if available. It can tolerate it better than native plants.

8) Stay on hay meadows longer if you can stand the impact of a potentially lowered hay supply. If irrigation water will be less than normal (it probably will be), concentrate it on your best-producing areas and graze the remainder. If you have a firm water supply, you might graze the entire area and delay growing the hay crop further into summer when good weather should mean more rapid growth.
9) Feed crop by products, if available.
10) Feed hay longer. Strongly consider this. Delayed breeding may be avoided and calf performance should stay up.

4. After the Drought

Resist the temptation to restock until you are certain your forage supply will permit it. Plants with a light to moderate grazing history will recover their productive ability fairly soon, perhaps the first year under above-average weather conditions. Plants which were heavily grazed will take longer to recover and some species will not if heavy grazing continues. Plants have to be given the opportunity to get enough energy to improve their vigor.

5. Make Drought Management Plans

a. What parts of your normal year plans can be used during drought?
b. Maintain all watering facilities and develop more if possible.
c. Keep some reserve feed.
d. Keep good production records on your cows. If you have to reduce, records will really help in determining sale animals.

I. Range Management--Transactions with Federal Land Managers

Beef producers who operate on federal land managed by the Bureau of Land Management and U.S. Forest Service have much at stake. Current and probable future land-management policies and philosophies are, and will be, different than those of the past. But, this does not mean you necessarily will lose privileges if you are knowledgeable of each situation.

Know what your grazing permit or license says and what it means. Try to determine where there is and is not flexibility. An attitude of friendliness and cooperation can pay real dividends. Remember that you are dealing with people, even when the structure may seem to be monolithic and cumbersome.

Be the leader in private-federal relations. Leadership does not mean being so dominant that relationships are strained to the breaking point. Recognize that reason can prevail and that managers are often trying to do balancing acts between several goals and interests. Managers and range conservationists will accommodate your concerns if they can see a way to do so. Try to be as familiar with the manager's directives, policies, and regulations as possible. Federal managers may be sympathetic to your causes and concerns but may not be able to do much about them.

First, be certain of your facts in every position you take. Have first-hand knowledge of the major plant species on the ranges where you operate. Know the range sites and the ecological condition of the vegetation. This will take some doing, but the knowledge is important to accomplish good management.

Know the history of management of each allotment. The mobility within federal agencies is such that most range conservationists, resource managers, and other resource personnel with who you deal will be moving from position to position on a regular basis. In a very real sense, producers have an educational role. If they play it well, they may find the results to be rewarding since they will be building credibility.

If your allotments had range improvements made in the past, keep good records of the impact they have had, both on the resource itself and on animal production. If improvements are planned, know something about the several alternatives proposed that could be used to meet the objectives. As an example for brush control, if prescribed fire is proposed instead of effective chemicals and some of the target species are sprouters, it should be pointed up that fire will not be effective and the brush problem could be made worse. Well-trained and perceptive range conservationists should know this. They may feel environmental constraints about the use of chemicals, however, and opt for fire. Be firm in your suggestions without being demeaning, but be certain to get your suggestions put into the resource knowledge base.

Being "up" on range management can put you in a good position to question actions or decisions that may appear questionable to you. Public land managers have the obligation to be responsive and they will be to responsible concerns. Conversely, permittees have the obligation to take corrective action in matters for which they are responsible. As an example, if you have been making use checks and find that realistic use levels are close to being exceeded, take the lead in moving the stock. By doing this your credibility is established. If the stock would remain even though the agency had not checked, exceeding use levels may be considered your responsibility rather than theirs.

Producers need to build a "savings bank" of good records. Keep account of stock movements, times, and numbers into which units, so animal-unit-months (AUM's) can be determined for each pasture. Keep track of the activities you have while in the process of operating on public land. These will aid in determining costs of operation.

Know where your stock like to be and don't like to be in range units. If grazing objectives are not being met, determine if some positive changes could help accomplish them. When at all possible, ask the range conservationist to take part in the riding effort. Finding that livestock management doesn't always work as the book says may be beneficial in helping develop realistic management objectives for the future.

Use a camera to help record what is actually there. Take pictures at both on- and off-grazing times. This, combined with AUM's, weather records and use-check information, will help you be a better manager and at the same time show the agency that they are not the only ones to whom records are important.

As a back-up to your memory, document all of your contacts with the federal agency. Just write it in your day book. Record who you saw, what you talked about, and whether any decision was made, no matter how small. The public land employee is required to do this too. It is unrealistic in our time to expect a public land manager or employee to look out for your interests. But, many of them will if you are a good cooperator.

Whether your allotment is operated under an Allotment Management Plan or a Coordinated Resource Management Plan, there will be some management constraints built into it. In virtually every planning effort, some compromise is necessary. If your allotments are being considered for plan alterations, play devil's advocate to help anticipate the alternatives you might have to consider in dealing with the public agency. Know what you can realistically do without imperiling your operation.

Cooperation does not mean you do it their way. It means that decisions are arrived at mutually and all know when, where, and probably how something is going to be done. Cooperation builds confidence.

Recognize that current regulations are more restrictive than in the past and the level of cooperation may be more difficult to attain. This doesn't mean giving up.

Consider legal action only as a last resort. Sometimes it can become the only course of action, and if that is the case, pursue it virgorously. Good resource management will not be handed down from the bench. It is even more probable that court decisions will result in less flexibility, which is to no one's favor. Thus, no one wins in the long run.

J. Range and Ranch Planning--Importance and Use

Building a successful range beef business can be compared to building a bridge or a large building--a design or blueprint is developed and the structure takes the form the blueprint calls for. The same occurs with the beef cattle enterprise. In this discussion, the emphasis is on range management and its relation to the total beef operation.

Range Management planning can be just for the range (and perhaps specifically the range-livestock resource) or it can be for all of the uses for the resource. The latter is called coordinated resource management planning. It refers to planning for all uses by various resource disciplines on lands that often are in both private and public ownership, although they do not necessarily have to be. Technical assistance from the Soil Conservation Service may be desirable or even necessary but you may want to tackle the problems and master the planning process yourself.

Five parts to the process exist. These are:

- Detailed inventory of all physical facilities. Include economic value.
- Detailed inventory of the resource base--rangeland, cropland, livestock.
- Problem analysis for the entire operation.
- Activity plans for necessary changes.
- Timetable for activities.

1. Inventory of physical facilities

    a. Both a listing and description of all improvements--buildings, sheds, fences, corrals, scales and working chutes, watering facilities in conjunction with improvements, all general equipment used in the ranch operation.
    b. Locate on an up-to-date aerial photograph.
    c. Value of facilities including depreciation schedules of capital equipment.

2. Inventory of the Resource Base

    a. Land resource. Acres of rangeland, cultivated land (leased or rented), including general information such as geographical location, boundaries, elevations, topography, soils, general erosion conditions, current production of both range and cultivated land. Locate all range sites with associated soils on aerial photographs.
    b. Forage resource. Inventory range condition for each range site. Attempt to determine range trend. Estimate or measure herbage production by range site. Estimate grazing capacity in AUM's, appropriate season of use, etc.
    c. Animal resource. Inventory numbers and kinds of livestock. Include production records when possible. Also include estimates of numbers and kinds of wildlife.
    d. Water resources. Identify and characterize all permanent and temporary watering facilities as well as potential sources of water. Locate on aerial photo.

3. Problem Analysis

    Problems are isolated and identified on a unit-by-unit basis. Analysis will help answer the following questions:

a. What is the condition of the important range sites? Are they near potential or will they have to be managed for improved range condition?
b. Are facilities adequate throughout the ranch and range operation to adequately manage livestock? If not, where are the weak points?
c. What are forage utilization patterns? Are pastures too large to obtain good forage use? Does additional fencing become necessary?
d. What range improvement opportunities are there on a unit-by-unit basis? What is the relative cost for each and the relative expected return?
e. Existence of poisonous plant problems, location and season of use.
f. Predator, rodent, or insect problems.
g. What are interrelated demands on the land such as hunting, recreation, logging, and farming?
h. What is the forage balance on the ranch both currently and with expected improvements?
i. Keep complete analysis of current livestock management operations and make comparisons with several alternatives, such as spring calving versus fall calving versus grazing yearlings, etc.

4. Implementing Changes and Improvement

a. After improvement opportunities have been identified on a unit-by-unit basis and the problem analysis made for each unit, set up time table to determine when improvements will be made.
b. In general, make those improvements on the better condition, high potential sites first, since these will respond the quickest. Save lower potential, very brushy and/or less desirable sites for later in the program.
c. Consider all opportunities (brush control, range seeding, modern grazing management plans, etc.) before decisions are made.
d. Consider what adjustments in livestock numbers, classes, and seasons of use may need to be made in relation to the kinds of improvements and the expected returns in forage. Consider low enough stocking rates so that each individual animal will produce near its genetic potential.
e. Consider all of the related management practices which will optimize income from the ranch including the supplemental feeding, animal health practices, etc.

5. Realization of Management Goals

   a. Make complete economic analysis of each range and ranch improvement.
   b. Keep production records for the ranch output and equate as closely as possible to real economics.
   c. Identify relative returns for improvement in relation to costs.
   d. Do not become too impatient with regard to payoff. These things take time.

K. Range Developments--A Key to Better Grazing Use

The purpose for range developments is to facilitate better and more efficient range use by livestock. Range developments are fences, stockwater facilities, and stock driveways. Each development serves specific funtions. Each one should add some overall benefit from not only an economic standpoint but from an efficiency of management point as well.

Good management is more than having the correct or adequate number of watering locations, fences, and roads or trails. Good management is being able to use these developments to best advantage for overall animal and plant production over a sustained time period. In other words, adequate range developments do not mean that adequate range management automatically follows.

Need for some kind of development occurs whenever the manager finds that overall range forage utilization and optimum livestock production are not well matched, even though substantial use of salting and riding may be used to distribute grazing. Range developments, as with range improvements, require capital cost investment, thus must be of economic benefit. Ask yourself: How many AUM's (animal unit month) of unused forage do I have? Where is it located? When is it available? Why don't the cattle harvest it adequately? If it is not accessible, will a road or trail make it so? Must stock be fenced into a particular area to force them to utilize it?

By knowing the relative amount of unused or underutilized forage, calculate its value based on realistic prices. This will give an estimate of the yearly increased increment of forage value. With this information and costs of particular developments, for example, 2 miles of fence and two water developments, you can analyze whether you can afford to make the investment.

1. Water and Its Sources

In addition to providing cattle with water of good quality, water developments can be an effective means of distributing livestock on the range. Regulating cattle access to water will permit better utilization of forage on previously poorly utilized areas. Location of water is important in controlling the movement, distribution, and concentration of stock. More locations are needed on steep than rolling terrain. Cattle will not travel more than ½ mile in mountainous terrain and no more than 1 to 1½ miles on level range and make even forage use. One watering facility for each 50 to 60 animal units is desirable if the unit is expected to be used all season.

When at all possible in rough terrain, stockwater should be located on sidehills or just off a ridge rather than in canyons. Cattle will graze down from water a greater distance than they will up from water. Amount of water needed varies by class of stock and season of use. Lactating cows and calves consumed 15 gallons per day in Oregon studies, whereas dry cows drank 10 to 12 gallons. Yearling heifers needed 8 to 9 gallons per day for a summer period, but only 6½ gallons per day if watered on alternate days. Water intake will be less on green forage in spring and when weather is cool.

Numerous kinds of water developments exist and are discussed here only briefly. For any new development, be sure to determine whether a permit needs to be filed for its use. In many western states the development and use of both surface and groundwater is controlled by state regulations. Before investing in water developments, consult the appropriate regulatory agencies to insure compliance.

Consult the accompanying chart to help determine the cost per AUM for water if you know the stocking rates for the areas to be served and the costs of the developments.

Streams are not considered as developments. If streams are only intermittent, consider providing a reservoir. Permits are required for reservoirs. On perennial streams public concern exists for bank protection and maintenance of high water quality. Consequently, use care in grazing intensities on

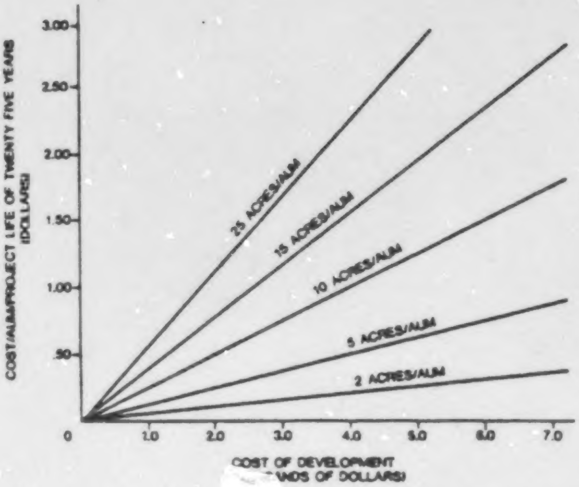


Figure 1. Cost of water development in relation to stocking rate. (From Duncan, 1973. Spring Developments-BLM mimeo, Ore-Wash State Office.)

such sites to prevent or minimize such breakdown. If the stream is fenced separately, make provision for water gaps. Care in construction will pay off in lower maintenance costs. It has been estimated that the dollar value for each day of maintenance can be as high as 15 percent to less than 5 percent of the initial investment.

2. Springs

Careful development is needed. A flowing spring has great value. Water could be tanked and piped great distances, spreading the value over several thousand acres. Low-flowing springs, if properly developed, can be very beneficial. For example, a spring flowing at only one-half gallon per minute produces 720 gallons per day, or enough for 48 cows and their calves during summer. In all cases, develop springs and seeps in such a way that stock do not have opportunity to trample the source. Several development techniques exist.

Often, location of potential spring developments is aided by consulting current aerial photos or by flying the area. Use of color, infrared film will allow water-loving plants to show up differently in the picture. Sometimes spring flow can be increased dramatically by removing trees and brush in the vicinity. Springs have started to flow following control of brush in several western areas.

3. Reservoirs and Stock Ponds

Success depends greatly on pattern and amount of precipitation and on the soil type. Often ponds dry up by late summer and fall, so their reliability as a water source is not as great as a spring, streams, or well. Care in construction is critical. Spillways are necessary. Specifications can be obtained from technical agencies. Reservoirs should be built with as small surface area as possible in relation to depth. High sides reduce wind movement and decrease evaporation. It often is desirable to fence reservoirs and either trough the water out through the dam or build a water gap.

Seepage can be controlled through use of materials like bentonite or special clays, or compacting the reservoir floor. Information about other techniques such as salt treatment or plastic liners can be obtained from the Soil Conservation Service or other technical advisers.

4. Wells

Vertical wells provide reliable water sources and often can be drilled near the forage supply. Cost of development may dictate how far the water can be extended. In much of the West, wells, storage tanks, and pipelines are a major water source.

Horizontal wells are a relatively new development in the West. Basically, a horizontal well is a pipe bored at a slight angle down into a hillside to tap small, seepy flows of water. Water flows of its own accord, by gravity, as with a spring. It is piped and can be controlled with valves. It is of high quality.

5. Hydraulic Rams

This age-old device deserves more use in the mountain West. Water from a spring or other sources such as a ditch or small stream is diverted into a drive pipe to the ram which lifts it through a delivery pipe. The basic minimum is a flow of 1½ gallons per minute with a fall of 20 inches or more. A theoretical lift to fall ratio of 25:1 exists. If water is needed at a higher elevation than a spring source, the ram has real possibilities.

6. Water Catchments

Numerous possibilities exist. Eastern Oregon studies show precipitation can be collected by using metal sheeting on a frame, shedding rain water into circular tanks of various sizes. Such developments can be placed anywhere the materials can be transported.

Research has been done on other kinds of catchments. The reliability of precipitation is an important factor. Catchments often are used where there is not enough precipitation for a stock pond and other sources of water do not exist. The principle is the same regardless of kind of catchment: precipitation falls on an impervious surface, is drawn off to a storage tank, and led into a water trough. Many types of surface can be used, flat rock outcrops, highways and roads, smooth packed soil (must have enough clay), chemically treated soil (silicone, parafin wax, sodium carbonate), mechanical covers (concrete, gravel-covered membranes, asphalt-soaked material, rubber and artificial rubber, sheet metal). The accompanying table gives some guidelines as to effectiveness and costs. If you wish to use catchments you are advised to get further technical help.

7. Pipelines

A great deal of range forage has been opened up since the advent of PVC (polyvinyl chloride) and plastic pipe. Piping is generally by gravity. Pipe should be buried but will work well above ground, although it will not last as long. Water can be turned on and off as desired, a definite advantage in influencing grazing distribution.

8. Hauling

This is generally considered as the last alternative in providing stock water because of cost, effort, and inconvenience. Costs have ranged as high as $10/AUM depending on the amount hauled, distance, and terrain. Hauling can result in distributing grazing to areas that otherwise would not be grazed. Stock may get to drink more often and generally do not need to travel so far when water hauling is practiced. Because of cost of hauling water the need for the forage must be considered carefully.

Roads must be maintained in good condition. Thus, very rough country is not conducive to water hauling. Move water tanks often to improve evenness of use.

Water Costs for Various Water Harvesting Treatments.

Treatment	Runoff	Estimated life of treatment	Initial treatment cost per yard[2]	Annual amortized cost[1] per yard[2]	Water cost per thousand gallons in a 20-inch rainfall zone
	Percent	*Years*			
Rock outcropping	20-40	20-30	$<0.01	$<0.02	$0.22-0.45
Land clearing	20-30	5-10	0.01-0.02	<0.01	0.30-0.45
Soil smoothing	25-35	5-10	0.05-0.07	0.01-0.02	0.25-0.71
Sodium dispersant[3]	40-70	3-5	0.07-0.12	0.01-0.02	0.13-0.45
Silicone water repellents[2]	50-80	3-5	0.12-0.18	0.02-0.04	0.22-0.71
Paraffin wax[4]	60-90	5-8	0.30-0.40	0.05-0.10	0.50-1.49
Concrete	60-80	20	2.00-5.00	0.17-0.44	1.89-6.53
Gravel covered membranes	70-80	10-20	0.50-0.70	0.04-0.10	0.45-1.27
Asphalt fiberglass[5]	85-95	5-10	1.00-2.00	0.14-0.48	1.31-5.00
Artificial rubber[6]	90-100	10-15	2.00-3.00	0.21-0.41	1.87-4.00
Sheet metal[7]	90-100	20	2.00-3.00	0.17-0.26	1.31-2.57

Source: Journal of Range Mangament. 28:430

[1] Based on the life of the treatment at 6 percent interest.

[2] Cluff, 1975.

[3] Myers and Frasier, 1969.

[4] Fink, et al., 1973.

[5] Myers and Frasier, 1974.

[6] Lauritzen and Thayer, 1966.

[7] Lauritzen, 1967.

9. Fences

Although water by itself is an excellent way to improve or manipulate grazing distribution, it is difficult to put a rotational grazing plan into effect without using fences to control livestock. Animal behavior will indicate where fences should and should not be. Consider the natural boundaries or barriers to livestock movement. Fences need be built only for the specific purpose the producer has in mind.

Every producer has or will develop guidelines for building fences. The following are general considerations:

a. Build along the contour whenever possible. The fence will be stronger and the cattle will not crowd it as badly.
b. Don't fence down a drainage bottom but, rather, split it at an angle.
c. Fence by site whenever possible.
d. Don't fence up and down slope, but at an angle.
e. Always remember the objective for the fence. You want to visualize how it will work before it is built.

Producers should consider suspension fences when terrain will permit. Both cost of construction and materials may be reduced substantially. When made properly, suspension fences actually turn cattle better than conventional barbed wire ones. The principle of spooking the animal through both the movement of the wire when touched and the sound from wind works well.

For use in country where deep snow packs are a problem, the let-down or lay-down fence has merit. This means a fence that is let down in the fall and put up in the spring. Yearly maintenance costs are reduced as compared to conventional fences where wires often are broken and posts pulled or bent over. Construction costs will be somewhat higher. Since the wires are on the ground during winter, their life will be somewhat shorter.

10. Roads and Trails

It is no secret that cattle use roads and trails just as humans do. Putting them into steep or both steep and timbered terrain will aid grazing distribution. Where commercial timber harvesting occurs periodically, roads and grazing go well together. Roads and trails can make gathering cattle much easier. As with other range developments, analyze what is desired first and then determine if developing more roads and trails will achieve it.

11. Other Developments

Corrals and handling facilities, stock driveways, and provision for shade require little discussion. The modern beef producer works stock several times each year. Doing some of that on the range is necessary. Construct a facility where several pastures join. Include a scale so performance by pasture can be determined.

Stock driveways may be on their way back, as the cost and availability of fuel changes. Whether such a passageway is required will depend on the number of times movement is needed and by how many cattle. Driveways historically were used for movements between seasonal feed sources. Less labor is necessary for moving along a driveway than in the open. This is a relatively more important consideration in the 1980's than in the days were labor was abundant.

L. Grazing to Maintain A Healthy Range

To a cow, grazing is the natural means of getting her daily sustenance. To the manager, grazing should be more than that because when and where she grazes has a great deal to do with maintaining and improving overall productivity of both plants and animals. Plants have differing nutritional qualities throughout the year and cattle, no matter where they are, constantly eat what they prefer and as much of it as they possibly can to meet their requirements. Therefore, managing grazing to meet both animal and plant requirements becomes a challenge that must be mastered in order to perpetuate the animal, plant, and soil resource.

Enumerable ways exist to achieve grazing management objectives. A number of factors need to be considered in developing and carrying out successful grazing plans. You need to visualize what animals are doing to each plant species each day they are on range and pastures. Grazing removes leaves and stems. The time of removal as well as the amount can have a positive, a negative, or even no effect on a plant and its immediate environment. If the effect is harmful, you need to know in what way it is harmful. With that knowledge, ways can be designed to overcome negative effects.

Try to visualize what grazing a plant is doing to its ability to grow and compete. At the same time, assess what the lack of grazing on associated plants is doing. As an example, cattle almost never graze big sagebrush except perhaps during a rough winter. Big sagebrush, therefore, is completely free to compete with the more desired species. The same can be said of other non-grazed species.

Thus, think of grazing in terms of how many animals there are for a given area, or intensity of use; how often grazing is done, or frequency of use; when grazing occurs in a plant's life history, or season of use; and what plants are being eaten, or selectivity of use.

On ranges in the West, there will be four periods in the year to consider for plants.

- Period 1 -- Initial growth, usually in spring. Soils are damp and cold. Growth is slow and leaves contain much moisture. New leaves are high in crude protein, minerals, and energy, but cattle cannot usually get enough new growth to satisfy their intake needs. Plant growth is less than animal demand unless stocking pressures are very low. This period is before traditional range readiness. If some of the previous year's residue remains, more of the animal's intake needs will be met and there also could be a lessening of the grazing effect on the plant. But, if more than one year's old growth is present, animals will avoid such plants and concentrate on the new plants, putting more pressure on them.

- Period 2 -- Plant growth is just about even with animal demand. This is usually a short time period, from a few days to a very few weeks at most. Nutritional values are just about adequate to meet requirements.

- Period 3 -- This is the flush period where animal demand is usually less, sometimes greatly so, than the forage supply. Nutrition is high, animals gain well during the entire period but less well as the end arrives. In this period, heavy stocking pressure will permit more uniform use of all species since all but the most undesirable ones will be grazed.

- Period 4 -- Dormant period. This will certainly be the dry season and may be during the wet season, also. There may or may not be a late summer-fall green-up which is a short time repeat of Period 1 but not of Period 2 and 3. Period 4 will be the longest period of the year. During this period, nutritional values may limit animal performance. Grazing selectivity will be high and many plants may go ungrazed. High grazing pressure will be necessary to achieve uniform use on all species. Ingenuity in grazing management is especially needed in Period 4. But, if good management has prevailed in the other periods, many of the negative factors can be sharply reduced.

1. Some Common Planning Terms

AUM. Animal unit month. The amount of dry matter to provide an animal unit with its needs for one month. One AU is commonly accepted as one cow with calf less than 6 months old. There is no agreed upon standard weight of forage. Figures of 750 to 1,000 pounds often are used.

AU EQUIVALENTS. Various conversion factors used with no universal agreement. Following are the suggested:

Cow with calf less than 6 months	1.0
Dry Cow	0.8
Coming 2 year old	0.8
Bull	1.25
Horse	1.5
Weaned calf	0.5
Short yearling	0.6
Long yearling	0.7

STOCKING RATE. Unit area needed to support 1 AU for 1 month. Expressed as acres per AUM.

GRAZING CAPACITY. Number of livestock that will yield the greatest production without damaging the land, vegetation resource, and/or other values from that resource.

CARRYING CAPACITY. Refers to the specific commodity for a specific time period, e.g., the summer carrying capacity for yearling steers.

OVERSTOCK. Too much grazing pressure for the amount of forage.

OVERUTILIZED. Too much use for the plants at any time, but generally the end of the season.

OVERGRAZED. Too much grazing pressure over too long a period of time.

CONTINUOUS GRAZING. Unrestricted use access during the grazing season. Does not refer to level of use.

SEASON or SEASONLONG. Grazed for the duration of a particular season of the year.

REPEATED SEASONAL. Grazed at the same season each year.

DEFERRED. Not grazed until the main forage plants have reached a set level of maturity, often setting of seed.

ROTATIONAL. Animals moved from pasture to pasture on a particular schedule. The schedule may be based on the calendar, on level of use, or stage of growth.

RESTED. No grazing during at least a one-year period.

REST-ROTATION. Scheme incorporating at least one rested pasture on a rotational basis.

SEASONAL REST or RELIEF. No grazing for various periods during the year.

If you need to get professional assistance in developing a grazing plan, make certain that the plan is more than just a series of animal moving dates from pasture to pasture. You should have direct input into developing the plan and have confidence that it will work. Use all the plant and animal knowledge at hand. Recognize the general times that the four periods will occur in each pasture and tailor the grazing to that.

No one kind of grazing scheme fits all situations best, but there may be some best program for your situation. It could be a combination of deferment, rotation of animals, some seasonal rest, and perhaps some continuous use. All approaches have merit in the right place with the right person. The skill of the manager is more important than any other factor. And, skills are learned.

Grazing plans should have objectives for each pasture unit. If no objectives exist, you will never really know how good your management is. As an example, let's say you have rated the range in unit "X" and the composition is made up of 60 percent less desirable plants and 40 percent desirable plants. You want to increase desirables to 60 to 70 percent. You know that to do this it will take a combination of Period 2 and Period 3 grazing with some growing season deferment. With either a known stocking rate or with an estimated initial stocking rate based on forage production, you can plan the management of the pasture and see how it fits with other pastures.

Move livestock in relation to plant growth stage and forage utilization, not by calendar. Be certain enough forage is available in the next pasture or another move will be imminent. Movements during Period 4 could be the exception to this, since one objective may be to graze all pastures each year.

2. General Observations

   a. Stocking pressure or grazing intensity is more important than the kind of grazing schedule developed. Heavy pressure at the "wrong time," combined with appropriate seasonal rest periods, can improve range productivity. But, there is a point to make -- How much is too much? It's up to the manager to decide.

   b. Pastures generally do not have to have all-season rest to maintain range forage yields. Grazing may loosen soil, plant seed, tramp litter into the surface, and cycle nutrients, Perhaps most important of all, it removes the old growth, which if not removed, will contribute to less uniform use the following year.

   c. Additional pastures mean more flexibility to the point of obtaining maximum safe forage use.

   d. Use stock water as a way to move grazing use. Fencing water from cattle or turning off water valve in areas that need relief can be effective in continuously or season-long grazed pastures.

   e. Continuous grazing should not be discounted as long as objectives can be met. Excessive stocking pressures have given continuous use a bad name.

   f. It is all right to use repeated seasonal grazing in some cases. Crested wheatgrass is a good example (spring-grazed each year).

   g. If a plan calls for more dollar expenditure, scrutinize the level of expected benefits. In other words, what is the point beyond which you can't get back your investment? You don't want to go that far.

   h. Cattle can be effective tools to improve ranges by closely managing forage utilization. Yearlings are the best class for this; next are dry cows. Cows with calves are least effective. But, you need to maintain good gains on yearlings so their use as management tools is restricted to times of adequate forage value.

i. Move cattle at the early end of "ready" period rather than the late end. Performance declines as grazing satisfaction declines.

j. Don't move cattle until forage is properly used. Then, have more than one pasture to go to. Emergencies can and do arise.

k. Seasonal grazing relief has real payoff in three periods: growth Period 1; the period from the time when growth buds of perennial grasses are elevating to seed maturity; and the period when late energy storage is occurring.

l. It is better to graze one pasture correctly and not use another at all in a particular season than to graze both improperly.

m. Producers should have a hand in developing grazing plans. Realism thus will be assured.

M. Range Improvements--Ways to Increase Forage Production

Range improvements are changes made by managers to purposefully change the vegetation with the intent to improve and increase forage quantity and quality. Through the range management planning process, producers will have identified their problems and the opportunities for correcting them. Some form of range improvement probably will be considered.

The producer should make a thorough economic analysis of each problem situation and its alternative solutions. A number of techniques are available to do this. One that all producers can use was developed by range management staff at Utah State University and published as Utah Agricultural Experiment Station Bulletin 466. It shows, step by step, how various improvement practices can be compared. Projected total income and the total costs over the life of the range improvement project need to be developed. From this, the rate of return for each practice can be determined. Correct assumptions are vital to the success of this approach. You need to understand clearly what production and management advantages and disadvantages accrue to use of specific practices. Since there is great variability in conditions, you are advised to obtain technical assistance for making a study of the alternatives. Some Extension agents and specialist and Soil Conservation Service technicians are trained in this field. They may know of alternatives you hadn't thought about.

1. Overall Consideration

Improving ranch productivity through range improvements has four main components:

a. Selection of most appropriate practice or practices for each site and situation
b. Management of the resource after it has been improved
c. Maintenance of productivity by retreatment if necessary
d. Integration and management of improved areas with the other resources of the ranch

Consider improving the highest site potential areas first. Often these will be some of the lowest ecological condition sites, perhaps abandoned cropland or areas near water. They may require seeding. At the same time, depending on the practices that might be used, consider improving the higher ecological condition areas before tackling the poor and fair condition ones. Good range responds to treatment more rapidly than poor, and there should be a greater level of biological stability. You also need to recognize, however, that the total amount of response may not be as great as from the lower condition sites.

Improved grazing management is a range improvement practice. Range vegetation can improve or decline depending on the kind of grazing management it receives. Consequently, keep grazing in mind as an improvement practice as well as just a way to maintain forage production and utilization. Maintaining use on all areas is essential. In years of too much grass, lack of use may encourage no use in the following years.

Many ranges have been improved initially through brush management or seeding, but productivity hasn't been maintained. The causes of range deterioration in the first place need to be well understood. If they aren't, range improvement may not be as long-lasting as expected. After range improvement has occurred, regardless of practice, be certain to apply a grazing strategy that will maintain the productivity engendered by the improvement. Producers must recognize that grazing animals can have good impacts or detrimental impacts on plants.

Finally, most improvements need followup. Understanding the kind of sites one works with will give large clues as to the kinds and amount of followup that will be needed. Often the same practices can be repeated for followup: for example, fire on big sagebrush, where many seedlings emerge. Repeat when necessary.

Prescribing the correct practice or set of practices for the various ecological sites requires good technical knowledge. If you feel you don't have that knowhow yet, don't be embarrassed to request some assistance.

2. Control of Undesirable Plants

A number of practices can be used to control plants. All result in opening the plant community to some extent. Closing the plant community with desirable species is the goal. This needs to take place correctly and fairly rapidly. Therefore, the conditions under which these practices apply need to be clear. Do not expect some desirable native plants to come back in rapidly just because you remove the bad ones, unless there is a sufficient population of the desirable ones already present. If there isn't, then consider seeding the desired species along with plant control of the undesirable. Some of the most successful seedings incorporate a practice like spraying sagebrush ahead of planting. Herbicides for chemical fallow employ the same principle.

Controlling undesirable plants, in and of itself, has several advantages and some disadvantages. Range improvement will be accelerated under the right conditions. Often water yield and availability improves. Stock have more accessability to forage and they are easier to handle when trees and brush are controlled. Poisonous plants may be controlled. Weed seeds may be reduced. Fire hazards should be reduced and often plant control improves habitat for game animals as well.

Although not necessarily disadvantages, plant control per se might not be appropriate when site potential is too low, when costs are too high and can't be spread out over a long enough time period, when serious erosion hazards exist, and when drift from sprays would cause problems where chemicals are the only solution.

From each general category of plant control, both advantages and disadvantages occur. A partial list is given here for each category.

a. Manual and Mechanical Control

Obviously, this means getting at the plant physically. Thus, the approach applies primarily to shrub and tree species. Manual means hand grubbing or chain sawing. Mechanical means, usually bulldozing or dragging with a heavy chain, often are utilized because no other practice is either effective or economical.

Advantages and disadvantages are not clear cut. Depending on the technique, high selectivity can occur (bulldozing) or low selectivity (chaining). Mechanical control often is a means of seedbed preparation prior to seeding.

1) Advantages

   a) Timing not critical. Can do when ranch labor available
   b) Generally considered most convenient of methods
   c) However, some plants are more and/or less sensitive at particular times of year, e.g., rotobeating sagebrush in the fall is generally less successful

2) Disadvantages

   a) May not have the desired equipment
   b) Costs may be rather high
   c) Often enough soil disturbance to require seeding (an advantage if seeding is desired)
   d) Terrain

b. Chemical

This general category of methods has been phenomenally successful in achieving range improvement. Use only chemicals that are registered by the Environmental Protection Administration (EPA) for that specific application. Because of this regulation, it is more and more likely that most chemical application will be made under contract by licensed applicators. This, in itself, doesn't relieve a producer of liability, as label instructions on the chemicals still must be followed. If contracted, less ranch labor will be used than in the past--at least for spraying. Chemicals come in a wide variety of forms, and can be applied in liquid (sprays or injected as into trees) and solid (graules primarily).

1) Advantages

  a) Very site-specific
  b) Rapid in terms of ease of application
  c) Generally low to moderate cost
  d) No erosion hazard
  e) Selective as to species
  f) Terrain not limiting as a rule
  g) Generally some moisture conservation benefits
  h) Ranch labor not needed, generally
  i) Safe as long as done properly

2) Disadvantages

  a) Timing is very critical for many herbicides
  b) Weather and environmental conditions can limit, e.g., soil moisture too low
  c) No chemicals yet for several major species
  d) Damage to crops in area

c. Prescribed Fire

When conditions for burning are accurately prescribed and adhered to, predictable results occur. The techniques, overall, are being developed to make burning a skillful management technique. Fire is environmentally accepted. It can be used as an overall part of a management program, as well as just for range improvement--as for example, to burn off old forage residue as an encouragement for better livestock distribution. This can be practiced on a periodic but planned basis. Studies are now revealing more information on times of fire tolerance as well as susceptibility of various forage species. Fire can be used effectively in maintaining productivity of an improved range.

1) Advantages

   a) Relatively low cost
   b) Forage plants preferred after burning
   c) Good seedbed preparation in white ash (shrubs and trees)
   d) Releases nutrients for plant growth--forage plants may be more nutritious
   e) Controls insect populations--insects prefer old residue; removes that
   f) Improves game habitat
   g) Opens up areas for access

2) Disadvantages

   a) Liability when escapes occur
   b) Need good preparation; i.e., often more than just firelines
   c) Does not kill sprouting plants
   d) Often damaging to non-target species as well as target ones
   e) Timing imporatnt
   f) Dangerous
   g) Some erosion hazard on steep slopes
   h) May not burn evenly--not as site specific
   i) Often vegetation not dense enough to carry fire

d. Biological

Grazing for particular purposes is a form of biological control. Such biological forms as insects and diseases, however, more often are considered primary for this overall approach. Many attempts are made to discover insects and plant diseases that will attack only one undesirable plant species. Only few examples of good success occur. In order to be considered for biological control, the organism must be specific for the host plant and should be controllable. Most such organisms are not native to the problem area.

Some natural biological control takes place. Notable is the sagebrush defoliator (Aroga websteri). Unfortunately, no one knows what factors control populations of the defoliator; it is unpredictable and populations ebb and flow through time. Two parasites work on both the larvae and papae stage.

Undoubtedly, biological control agents will be found for more and more undesirable weeds in the future. However, it is unlikely that this form of control will be allowed on native species, unless the control organism can be controlled effectively itself.

3. Range Seeding

Seeding is second to brush control in terms of number of improved rangeland acres. Producers turn to seeding for range improvement because it can offer at least as much, and usually more, forage that is palatable and nutritious than unseeded native range, often at times when native species are less palatable and nutritious. Seedings for early spring use offer a source of feed for cows in early lactation, which need abundant good nutrition to recover well from calving and start to cycle on time. Additionally, seedings for early spring use permit deferment of use on native ranges, which may allow more rapid range improvement than would come about otherwise. Often, seeded species are not only more productive than the natives they replace; but they are usually more tolerant to grazing. This will be especially true if the planted species is introduced and not native. Crested wheatgrass, used since the mid 1930's, s the model for this purpose. Early, palatable, and nutritious, it consistently allows the producer to get cows and newborn spring calves off meadows before native species are ready for use.

Seeding is indicated under a large number of situations, but most seeding is done for one or both of these reasons: (1) there is a need for forage that the present species composition and site characteristics cannot fulfill, (2) the current ecological condition is poor and site potential is high. In such situations, those sites with deepest soils, moderate to no slopes, and sites of sandy loam to loamy surface soil should be the first candidates.

As with any other range improvement practice, seedings should be scheduled far in advance. Since finances are generally limiting, a schedule of planned activities might include seedings spread over a period of several years. Species can be planted for more or less specific cases. This should give a manager much more flexibility than having to operate on native range alone.

Seeding success will be limited when annual precipitation averages less than 9 inches. This is particularly so if soils are saline or alkaline as well. Opportunities for range improvement on such sites are limited mostly to improved grazing management, unless the soil moisture supply can be augmented.

In species selection, the primary consideration is: Will it establish, grow, and reproduce under my conditions? Such characteristics as drought tolerance, winter hardiness, and season of growth take on great significance. Once a list of adapted species is found, the remaining characteristics center around its use under your conditions. Will it be productive when I want to use it? How much use will it take and how does this vary from season to season? What is its relative palatability? Will my cattle eat and like it? Is its forage value enough to promote desired levels of animal performance?

Seed must be planted somehow, in some way. Broadcast seeding, except immediately following a forest-type fire, usually is not successful. Seed must have soil or some water-holding or retaining material around it in order to germinate and establish. The competing vegetation will need to be removed, a shallow but firm seedbed prepared, and the seeding must be done at the proper season. Rate of seeding, depth of seeding, width of drill rows, season of seeding--all are points needing attention to accomplish success. Attention to detail can be the difference between phenomenal success or absolute failure.

Seeded pastures should be fenced separately from other rangeland to permit grazing management. Don't graze until the plants are well established. This is usually reflected by development of a seed crop. There is one exception to this. If the initial stand has many weeds, like cheatgrass, grazing for a very short time (few days) with a large enough herd will significantly aid weed control and stand establishment. Graze when soil moisture is available and remove stock long before moisture is gone. Such short-duration grazing should not exceed about 10 days. Close management will result in a strong stand.

Recovering investment costs is a function of both the cost itself and the management of the seeding. A great deal of flexibility in use exists as compared to native species. A number of grazing plans may be used. If correct grazing occurs at least once per year, old growth will not build up and poor utilization should not occur. Frequently the entire pasture is not seeded. After 2 years of non-use, grasses present in the pasture will not be nearly as palatable as newly seeded grasses. This should be considered in a grazing management program. Although many of the seeded species are quite tolerant to grazing, paying attention to amount and time of grazing pressure will be economically important.

4. Mechanical Range Improvement

In areas where high intensity storms occur during the growing season, opportunity exists for a good deal of the water to run off, even when good vegetation cover is present. A number of different practices have evolved to solve that problem on rangeland. All were designed to aid range improvement by decreasing water runoff, conserving soil moisture, and increasing efficiency of water use. Practices include contour furrowing, contour terraces, ripping, pitting, and water spreading. Only furrowing, pitting, and perhaps water spreading can be recommended as economical. They work well for medium- to heavy-textured soils, but don't show much promise for sandy soils.

a. Contour Furrows

These are furrows 2 to 5 feet apart and about 8 inches deep, laid on the contour. Newer equipment places small dams in the furrow at periodic intervals. Water is held at its source, increasing soil moisture storage at relatively low cost. It is most applicable to medium to medium-fine textured soils.

b. Pitting

Pits are relatively shallow depressions in the soil surface. The objective is to hold water where it falls. Production on shortgrass range increased 30 to 50 percent after pitting, with a change to midgrass, mostly western wheatgrass. Life of pits is limited, however, since sediment builds up over a period of time, which reduces the effectiveness.

c. Water Spreading

This is a form of irrigation whereby water is diverted from areas of concentration to nearby relatively flat, smooth areas to augment the natural moisture. A good knowledge of runoff characteristics is needed in order to decide whether water spreading is feasible, since dikes must be constructed to funnel the floodwaters over the land. Often, the area should be seeded and perhaps even fertilized, since the moisture regime, on average, will be better than it was before water spreading. An important consideration is the probability of floods each year. The cost of system development must be borne by increased productivity and the number of floods per year strongly influences its profitability.

5. Range Fertilization

Fertilization is a practice that must produce returns the year the fertilizer is applied. From that standpoint it is a different kind of range improvement practice. In areas of less than about 15 inches of annual precipitation, the plant's limiting growth factors are mostly weather-related. Nitrogen has been shown to increase a plant's ability to utilize water, but cost may not justify this increase. Additionally, native species in these arid to semi-arid environments evolved under those conditions and often are just not economically responsive to additional levels of plant nutrients.

Fertilizers are not effective unless growing season moisture occurs, which generally limits their use to the Great Plains and mountain valleys. Species such as crested wheatgrass have been fertilized economically with nitrogen in precipitation areas less than 15 inches, but results are erratic from year to year.

Benefits of fertilization include increased forage yield, higher nutritive value and forage quality, a somewhat longer green forage period, and increased soil moisture efficiency. As a rule, the species composition will be effected by nitrogen fertilization, In areas where both cool and warm-season grasses exist, a shift toward more cool-season grasses probably will occur if the area is fertilized either in fall or early spring. Or, where both annual grasses and perennials are fertilized, annual grass yield will increase to the detriment of the perennials. Nitrogen and sulfur are commonly deficient in western semi-arid areas. Phosphorous may or may not be deficient. Obtain soil tests to determine the major deficiencies.

Grazing animals must be on hand to consume the extra forage from fertilization. If you are in an area of consistently good late spring moisture and could use more forage then and in summer, fertilization, especially of seeded pastures, could be desirable. The range could be stocked with animals to that expected level of forage production.

Conversely, if moisture is consistently the most limiting factor, the stocking level should be in relation to the average, or slightly below average forage supply. Fertilization would only stimulate more forage in the above-average moisture years when more forage is generally available than can be used anyway. Consequently, fertilization on dryland ranges, whether native or seeded, is often a questionable practice.

Mountain meadow vegetation, whether seeded or not, should respond to nitrogen and sulfur, and perhaps phosphorous also, depending on the legumes present. Legumes need relatively more phosphorus and sulfur than do grasses and grass-like plants. Thus, to keep legume production, the need for phosphorous must be satisfied.

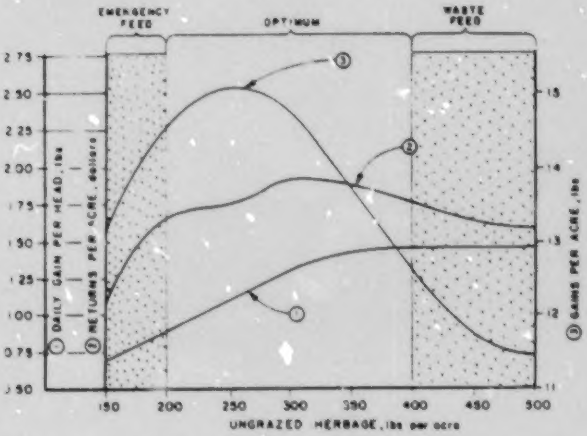
With the cost of all fertilizer certain to increase, the practice of fertilization requires close economic scrutiny. Usually you can profit by fertilizing irrigated hay meadows and pastures.

N. Using Forage Effectively for Beef Production

What is optimum forage use? Producers will need to define it for themselves. A qualitative definition might be: grazing in a manner that range plant health is maintained or improved, while the largest amount of useful animal product is produced over a sustained time period. A shortened version might be "getting the most from the resource while maintaining its productive potential."

Research studies in many states reaffirm that optimum use of range forage results from a mixture of the right numbers of animals (grazing pressure), the correct time period or season of use, the best overall distribution of animals, and the best-suited kind and class of grazing animals. Information learned through range management planning is necessary to apply these four grazing principles correctly.

Studies show further that the amount and form of herbage left after completion of grazing is more important than stopping grazing when a certain percent utilization by species has been achieved. It is important for one primary reason--optimum economic returns over a period of years will be at a particular point in terms of residue or herbage left. There is an optimum amount of plant material to maintain the plant community and provide soil-plant stability, also. The figure illustrates the principle when season-long grazing was used over a 19-year period. Note that maximum gains per head, per acre and economic returns per acre do not occur at the same level of grazing pressure. Development of such relationships for each range unit would help greatly in designing a better overall management program.



Optimum animal production is neither with maximum gains per unit area nor per head. Moderate stocking provides most returns in the short run and assures continued high yields of forage. Reproduced with permission from *Range Management*, Stoddart, Smith, and Box, McGraw Hill, 1975, p. 273.

So--manage grazing according to how much is left, not how much is taken. Forage plants grow, reproduce, and go dormant throughout the year. Forage quality begins at a highly digestible level in early season, reaches an optimum level of nutrient productivity in mid season, and declines during dormancy. Animals require forage intakes of varying quantity and quality, based on physiological demand. Mixing and matching these three components is the key to obtaining optimum forage use.

Regardless of location and ecological type, the forage cycle has at least four periods: (1) early growth, damp soils, high succulence, low daily productivity (easy to have demand exceed supply); (2) beginning of rapid growth, where demand and supply are about equal; (3) flush of growth, where supply exceeds demand; and (4) dormancy, where there is no new growth and lowered feed value.

Highest animal production occurs in Period 3. Each producer should calculate when these periods or phases occur for each range and pasture unit. By doing so, producers are in a position to match the demand and supply.

Simply put, range readiness is that time after which forage plants can safely sustain proper grazing without negative effects. It is a concept that long has been used but may no longer be important if intensive enough grazing management can occur. A serious problem with application of the concept is the variation from year to year in range readiness. Reports indicate readiness varies more than 6 weeks in different years on native ranges. Management must develop means to cope with this high variation. These are discussed in another publication on Grazing Management.

1. Forage Use Will Depend On

    a. Terrain or topography. Cattle, as a rule, are lazy and do not climb hills unless they must, and not well until they become acclimated to them. Thus, steeper areas will be undergrazed when the bottoms are correctly grazed. Using fencing to separate similar terrain areas sometimes is effective. Yearling cattle will graze steep areas better than cows and calves.

    b. Vegetation type. Cattle will not graze shrub type of range as evenly as grass types during the growing season. Fall and winter grazing on shrubs should increase the proportions of grass, since grasses should be less preferred or not as available at that season.

c. Availability of stock water. On level ranges, cattle will go as far as 4 miles for water, but distances as much as 2 miles will severely limit use. When combined with either steep or long slopes, forage occurring more than 1/2 to 3/4 mile from water will receive very little use unless the range is overused at closer distances.

d. Class of animal. Younger animals will range over steeper terrain and farther from water than cows with or without calves. Similarly, dry cows will utilize forage farther from water, on slopes, and in timber, better than wet cows.

2. Determining Use

There are two major purposes for use determinations. First, only by knowing where areas of differential utilization occur can you design plans to make better and more efficient use of your range resources. Second, overuse or misuse is the greatest contributor to either range deterioration or the lack of improvement in range condition. Knowledge and a record of forage utilization by area, coupled with periodic assessments of range condition, will be indispensable as keys to long-range planning.

If good past records are available, and the grazing plan developed for the area works well, future utilization checks will be used as much to check cattle as for forage. Make notes by date and species. Each season is different enough so that building a record will add significantly to your knowledge for use in the future.

After stock are removed from a pasture, make a use map showing areas of proper use, no use, underuse, and overuse. This will be desirable in designing the next season's grazing plans. If the pastures are large, the use maps are an aid in determining where further range developments might be needed. Watering locations in areas of underuse or no use are like buying more forage. Subdivision by fencing may be necessary to accomplish that purpose also.

Appendix A

DESCRIPTIONS OF IMPORTANT GRASSES

BARLEYGRASSES

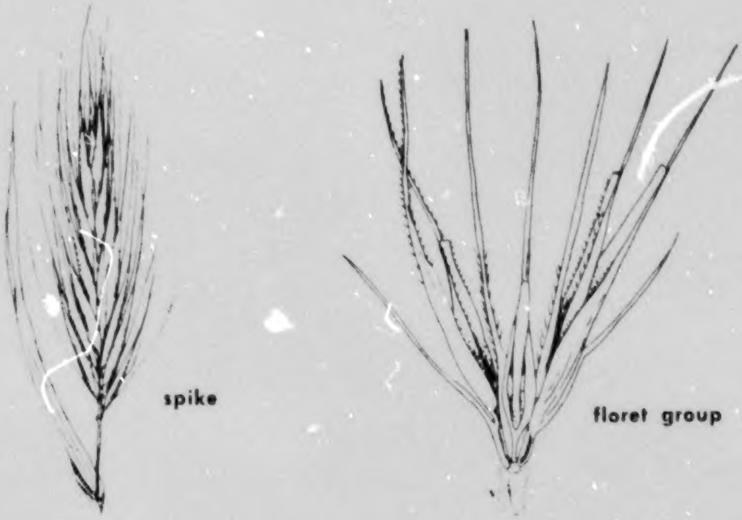
Hordeum spp.

The barleygrasses are either annuals or perennial bunchgrasses with dense, bristly spikes which shatter at maturity. The spikelets are arranged in groups of three, alternately on opposite sides of the stem. Each has one central, fertile floret and two sterile florets firmly attached. The florets are long-awned and the glumes bristle-like. Leaves are flat and occur on upper and lower portions of the stems.

The barleygrasses are found on a variety of sites but are most common in grasslands and along roadsides and disturbed places. Although widely distributed, they tend to occur in patches. As a group, the barleygrasses are considered as only fair forage since they are grazed early in their growth before they become undesirable when the harmful seed heads mature. The barleys are well-known for causing "foxtail" injury to the eyes and mouths of cattle and sheep.

Foxtail barley (*H. jubatum*) is an undesirable perennial resembling squirreltail but having finer, straighter, much longer awns. This species is grazed by livestock and game animals when young but is a troublesome weed when mature, especially when it is harvested in hay fields.

Mouse barley (*H. leporinum*) is an annual more common to the Pacific Coast but similarly undesirable. It is a source of winter feed for sheep and cattle but is early-maturing and objectionable as the spikes mature and shatter. Mouse barley, like the other barleygrasses, produces an abundance of viable seed and is difficult to eliminate.



Mouse Barley

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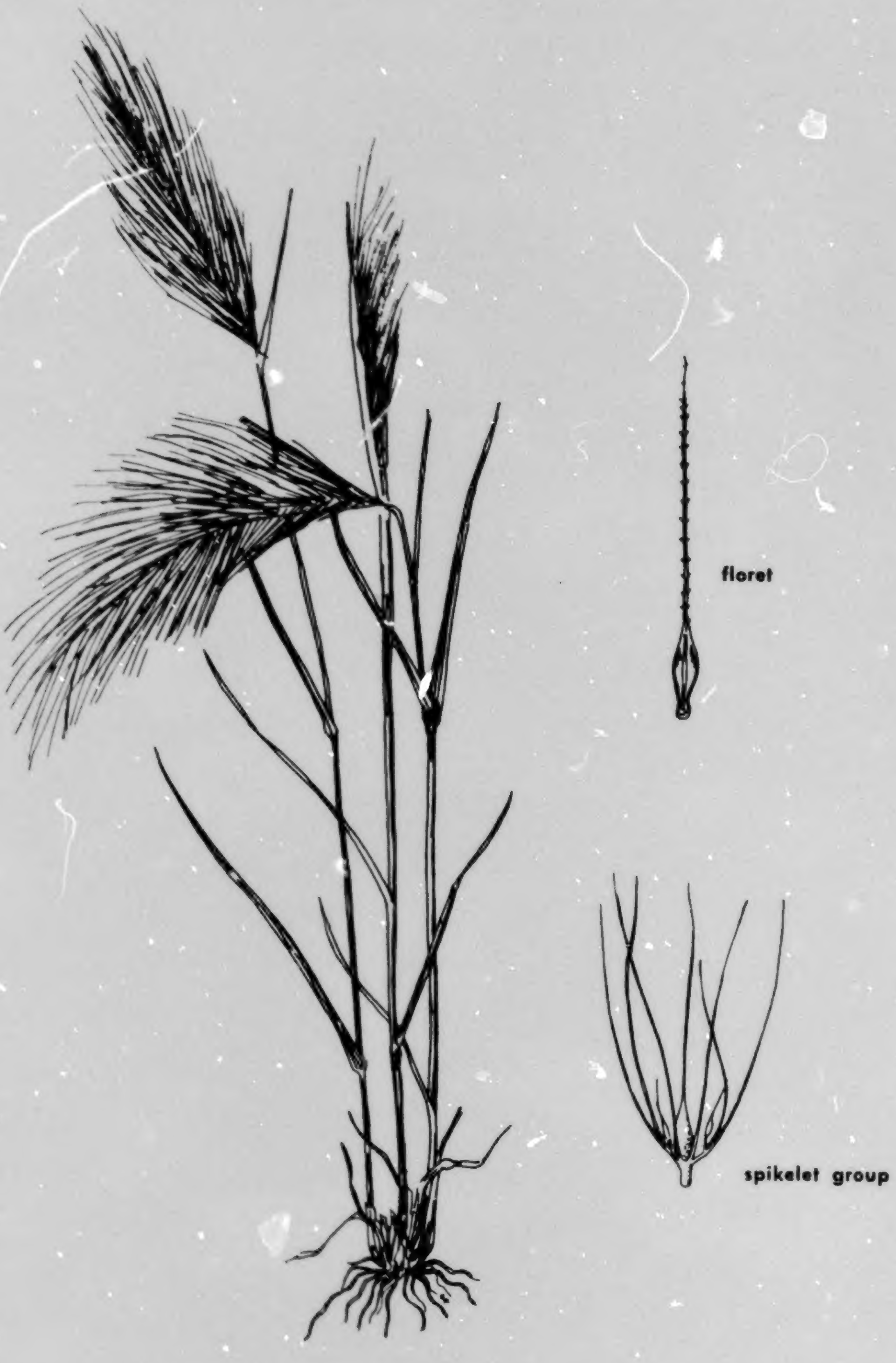

floret
spikelet group

Foxtail Barley

BLUEGRASSES

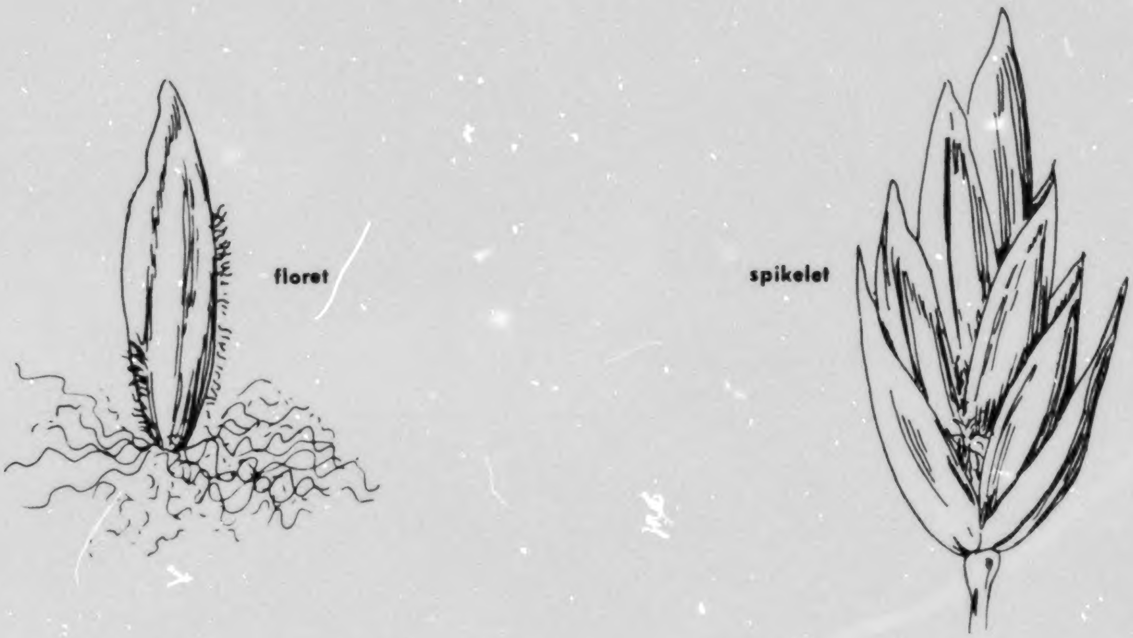
Poa spp.

The bluegrasses are the largest group and most widely found of the western range grasses. They are characterized by small spikelets in open or dense, narrow panicles. Florets have lemmas without teeth or awns at the top and often with cottony hairs at the base. The leaf blades may be folded but always have boatshaped tips. Nearly all are perennials.

The bluegrasses occur at all elevations on nearly all important sites, but are not common on southern desert ranges. All are highly palatable and nutritious for livestock and big game.

Kentucky bluegrass (*P. pratensis*) is one of the most valuable grasses in the United States and is commonly seeded for pasture. The panicle is spreading with spikelets of three to six florets, each with cottony or cob-webby hairs at the base. This bluegrass is a sod-former which grows best in cooler, more moist meadow sites of our mountain regions. The fine foliage is grazed throughout the late spring and summer and is considered excellent forage.

Sandberg's bluegrass (*P. secunda*) is a perennial bunchgrass forming short tufts of fine, dense foliage. Panicles are narrow with a dense group of two to four flowered spikelets. Sandberg's bluegrass is found from intermediate to high elevations primarily on shallow, dry sites within sagebrush and open timber. It matures early, but is good forage both green and dry.



Kentucky Bluegrass

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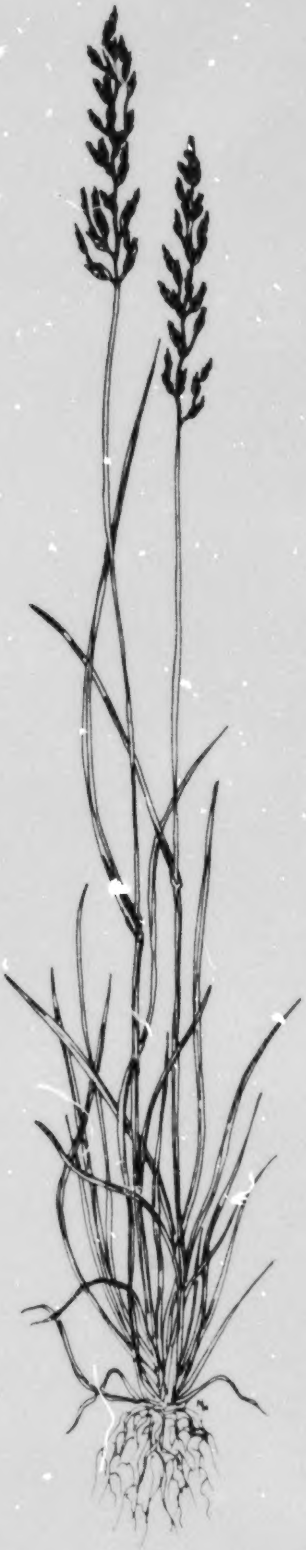
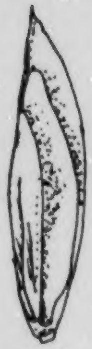
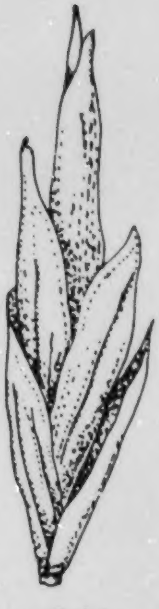




floret



spikelet

Sandberg's Bluegrass

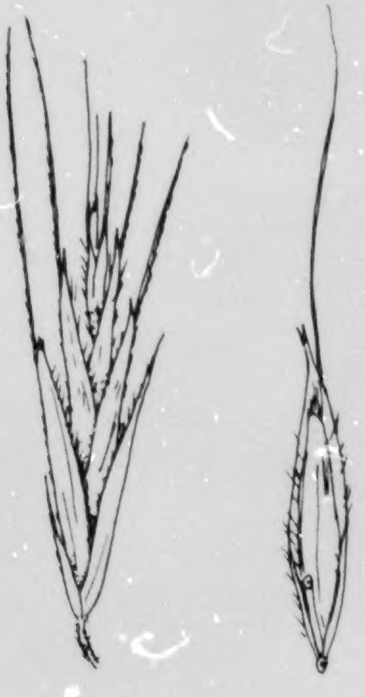
BROMEGRASSES

Bromus spp.

The bromes are a very large and important group including both annual and perennial forage species. Bromegrasses are distinguished by flat, rather broad leaves and mostly loose, spreading panicles. The spikelets usually contain several florets, the lemmas having a boat-like keel and notched or two-toothed tip between which an awn is present in most species.

The annual bromes are fine-stemmed, rather short, erect grasses which grow rapidly in early spring following germination of seed in the late fall or winter. They are valuable forage during the early season at lower elevations and are rated fair to good for all classes of stock.

The perennial bromes are larger and produce more leafy growth than the annuals. Generally, they require better sites and make growth later in the season. Although they tend to be rather course, the foliage is liked by all livestock and is grazed throughout the late spring and summer.



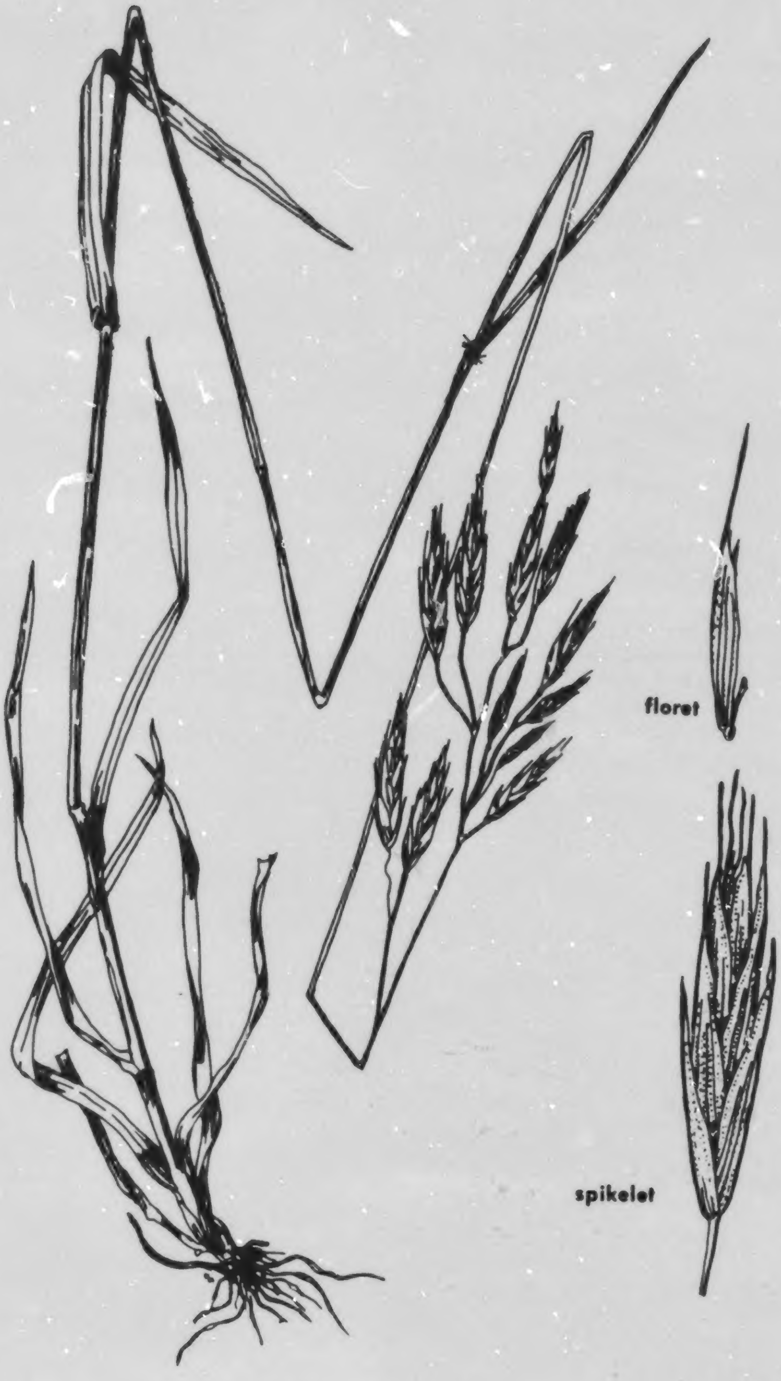
Cheatgrass spikelet and floret

Cheatgrass brome (*B. tectorum*) is an introduced annual of all but the southwestern states and extreme Pacific Coast. Panicles are loose and drooping with numerous slender spikelets having long awns (nearly ½ inch). The panicle and leaves are covered with soft, dense hairs. Cheatgrass is of particular value on poorer sites for early spring grazing but is less palatable and nutritious at maturity.

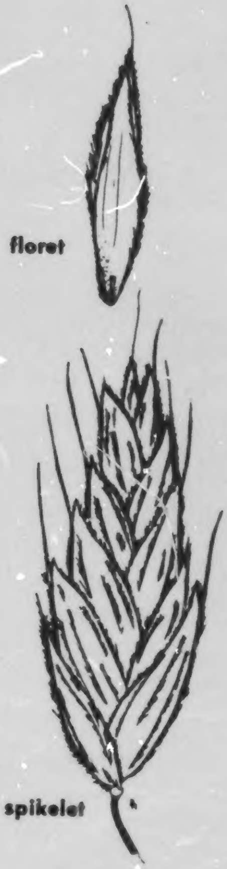
Softchess brome (*B. mollis*) is also an introduced annual but has a tight, erect panicle of few, rather large, hairy spikelets. Florets are many with short awns about 1/3 inch long. Soft chess is mostly a California species where it is one of the most valuable annual grasses. It is highly palatable both green and dry and is considered excellent forage for cattle and sheep.

California brome (*B. carinatus*) and mountain brome (*B. marginatus*) are native, short-lived perennial bunchgrasses of remarkable similarity in all characteristics. Panicles are open, somewhat stiff, but drooping and contain several large, awn-tipped, flattened spikelets. These bromes are mainly tall, mountain species of open sage, pine, and fir sites, and are considered excellent forage.

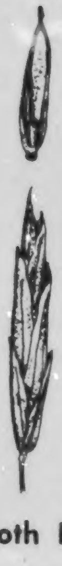
Smooth brome (*B. inermis*) is an introduced perennial sod-former widely seeded on a variety of sites for grazing and hay. Its smooth, awnless spikelets are several-flowered and form an open, erect panicle. The smooth, broad foliage is highly palatable and nutritious and excellent for spring and summer grazing.


floret
spikelet

California Brome


floret
spikelet

Softchess Brome



Smooth Brome

FESCUES

Festuca spp.

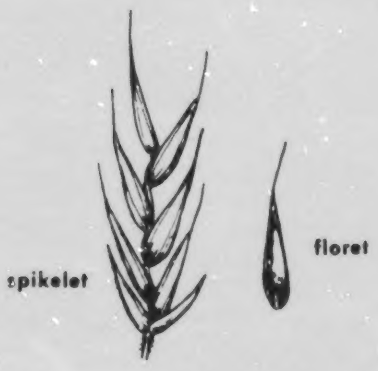
The fescues are one of the more important groups of forage grasses for range livestock. Both annuals and perennials are found in all western states. The fescues are identified by mostly fine stems and slender leaves, and narrow or slightly-spreading panicles. Spikelets have few to several florets each with boat-shaped, rounded lemmas tapering to a point or more commonly, a short awn. Both the glumes and lemmas are keeled, especially near the tips.

Annual fescues inhabit more shallow soils or drier sites and are inferior in forage production and value to the perennial species. The following description includes two important perennials and one common annual.

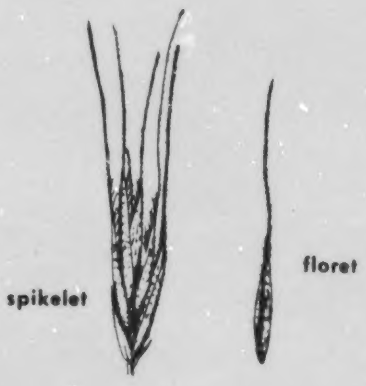
Sheep fescue (*F. ovina*) is a small, tufted bunchgrass native to the Intermountain area. Its short leaves are very fine, enrolled, and grow numerously from the plant base to about 6 to 12 inches. Panicles are narrow and spikelets small with 3 to 6 awn-tipped florets. Sheep fescue is widely found at 3,500 to 11,000 feet elevation and is excellent forage for all livestock.

Idaho fescue (*F. idahoensis*) is a native bunchgrass with dense bluish-green foliage from 12 to 36 inches high. Spikelets are in narrow or spreading panicles. Each has four to eight short-awned florets. This grass is very similar to sheep fescue but is larger and more common. Idaho fescue is found mainly at elevations from 3,000 to 7,500 feet on well-drained slopes and flats with sage and pine. It is one of our most valuable grasses and is often used as a key forage plant for management. Idaho fescue is highly palatable to all livestock and is ranked as excellent forage at all seasons.

Foxtail fescue (*F. megalura*) is a native, short-lived annual. It has a narrow panicle of spikelets each borne on very short pedicels, and with four or five loosely-arranged florets. Seeds have long awns and shatter easily at maturity. The foliage is sparse and grows from 4 to 18 inches in height. Foxtail fescue is found at low elevations, most commonly on south slopes or thin soils and is rated as only fair forage value and palatability at all seasons. It is rarely injurious to stock.



Sheep Fescue



Foxtail Fescue

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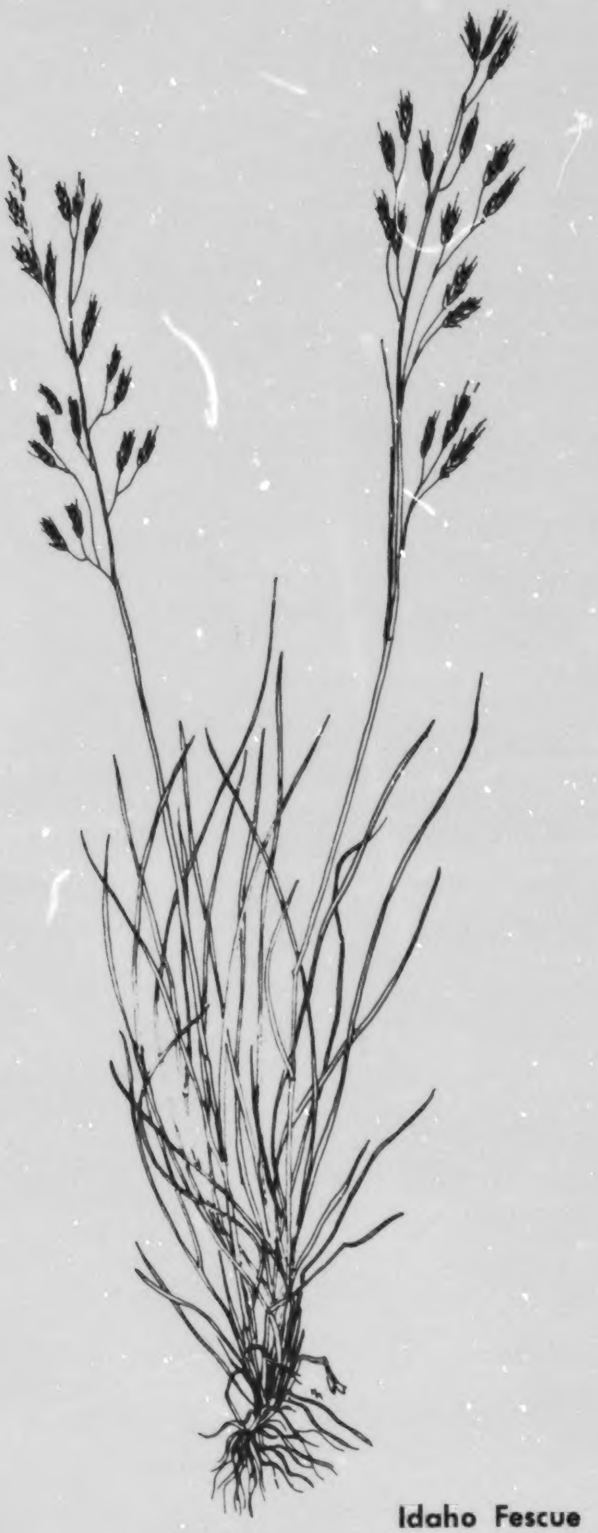
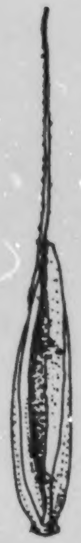
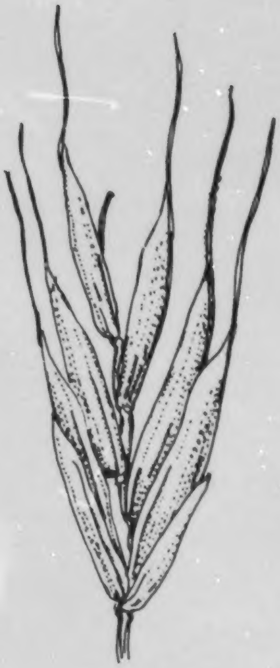




floret



spikelet

Idaho Fescue

GRAMA GRASSES

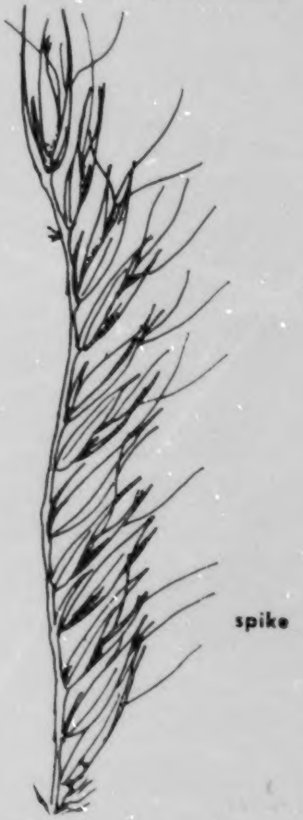
Bouteloua spp.

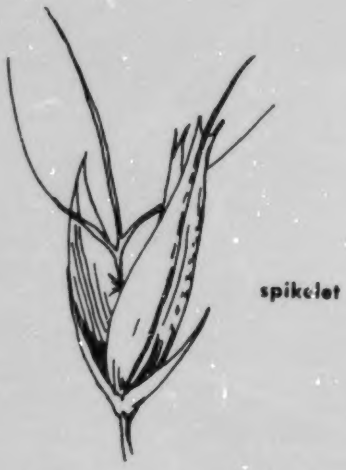
The gramas are mostly low-growing bunchgrasses or sod-formers. In all of them, the flowering head is a branched spike, each branch like a flag crowded with short spikelets in two rows on only one side. Each spikelet has one fertile floret with one or two sterile florets attached above, all having short awns. The leaves are narrow, short and massed at the base of the plant.

The gramas grow in open, dry soils from 3,000 to 7,000 feet on southwestern desert ranges mainly of New Mexico and Arizona. They are drought-resistant and generally regarded as excellent forage for all livestock. The gramas green-up in brief periods of summer rainfall and "cure" well. In other words, they retain their nutritive value when dry. They also withstand grazing well and are utilized year-round. The two most important grama grasses which are common and representative are blue grama and black grama.

Blue grama (*B. gracilis*) is a dense bunchgrass or sometimes a sod-former having fine foliage about 6 to 18 inches in height. Each flowering stem bears one to three spikes about one inch long. Each spikelet has one fertile floret with three teeth on the lemma, and one small, sterile floret of three awn-like bristles. Blue grama is the most common species of grama grass in the western states.

Black grama (*B. eripoda*) is a sod-forming perennial, spreading by stolons above the soil. It is similar to blue grama but has four or five flag-like spikes on each stem and wooly hair at the base of the spikelets and stems. Black grama is a key forage grass of most southwestern ranges.





Black Grama

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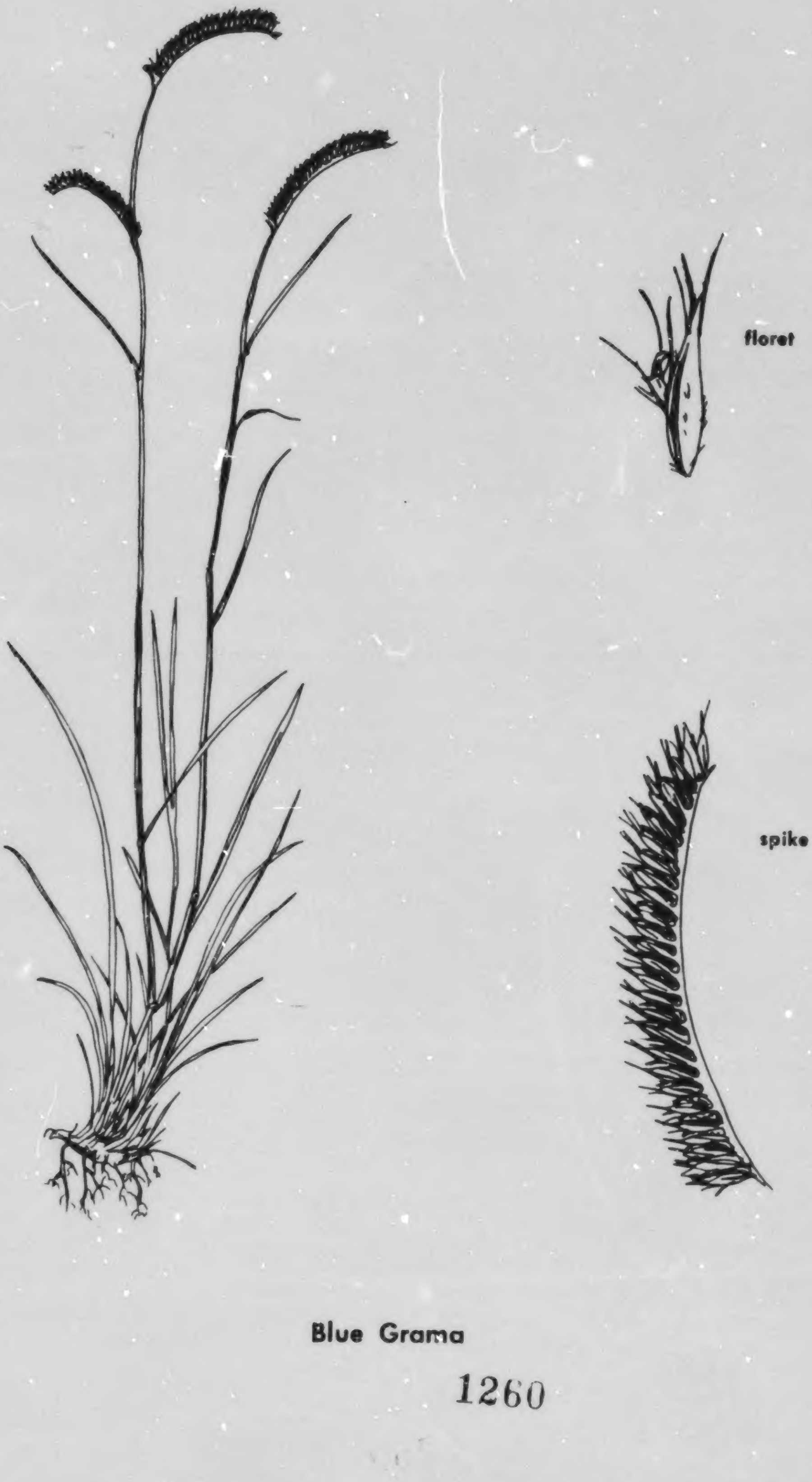

floret
spike

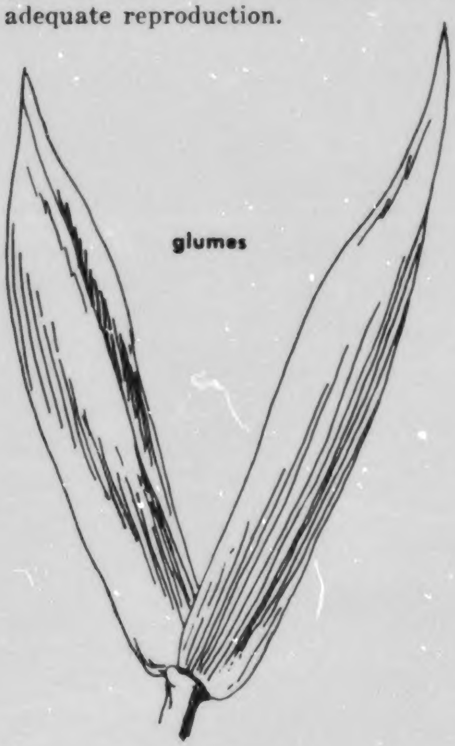
Blue Grama

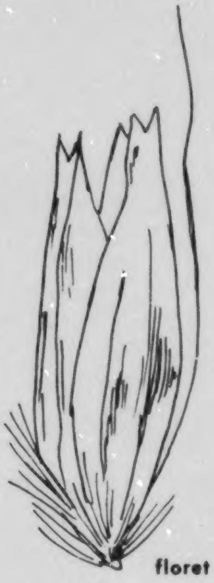
HAIRGRASSES

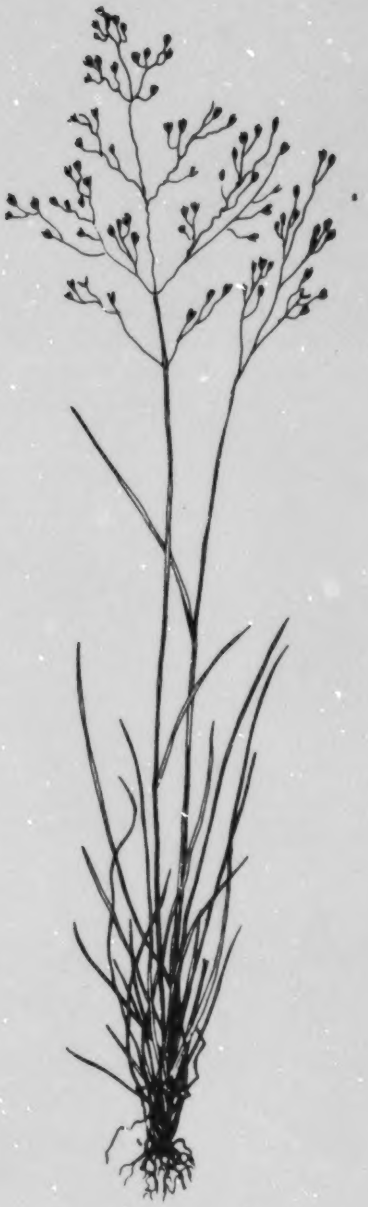
Deschampsia spp.

The hairgrasses are mostly fine, tufted perennials. They have narrow leaves usually folded and rather small, shiny, purplish spikelets in narrow or open panicles. Each spikelet has two florets, bearing a slender awn near the base of a toothed lemma.

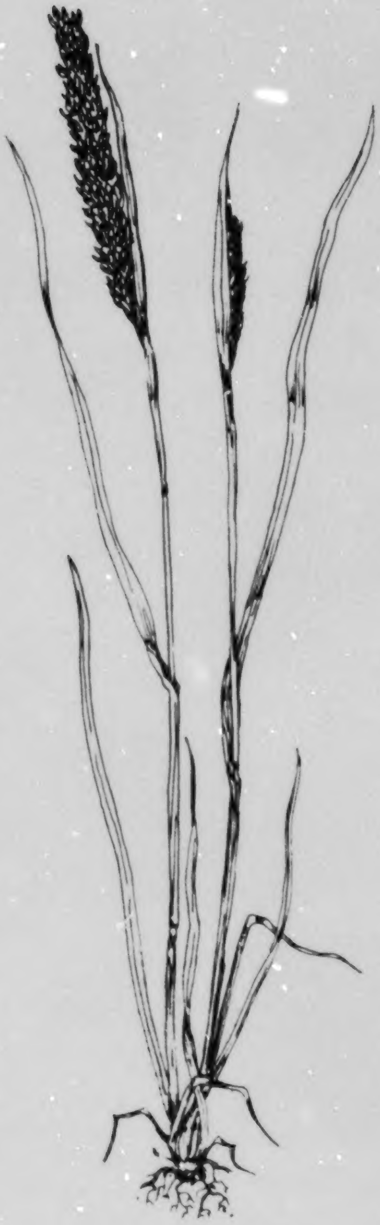
Tufted hairgrass (*D. caespitosa*) is one of the most widely distributed of our western range grasses and best represents the hairgrasses. Its foliage is mostly bright green, and the erect stems grow to about 3 feet. Spikelets are borne near the ends of fine but stiff pedicels in an open panicle. Tufted hairgrass often dominates mountain meadows above 5,000 feet and is relished by all classes of livestock. Because of high palatability, it is usually rated excellent in forage value. Although it seems resistant to grazing and makes good regrowth, sufficient seed must remain for adequate reproduction.

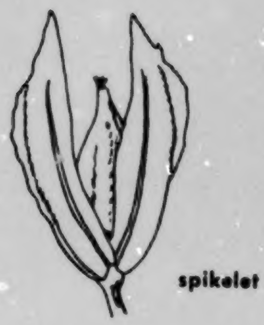


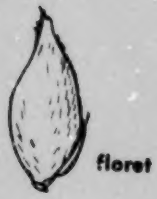




Tufted Hairgrass







HARDINGGRASS

Phalaris tuberosa

Hardinggrass is a cool-season, long-lived perennial bunchgrass with short rhizomes. The stout, leafy stems grow as much as 2 to 4 feet tall. Leaves are rather wide and short, smooth, and blue-green in color. The dense, spike-like panicles are 2 to 6 inches long and bear numerous, crowded, flat spikelets with broad glumes enclosing one fertile seed.

Hardinggrass was introduced from Australia and has proved an extremely promising and valuable perennial for seeding on old grainland and cleared brushland in California. It has been widely planted and has become naturalized in many areas. It is excellent forage grass because it is highly palatable and nutritious, especially in early growth stages. Hardinggrass is readily eaten by all kinds of livestock and big game animals. Since the plants tend to become rank and tough with maturity, forage value is increased if the plants are grazed or mowed frequently to maintain active growth. Once established, Hardinggrass can withstand heavy grazing.

NEEDLEGRASSES

Stipa spp.

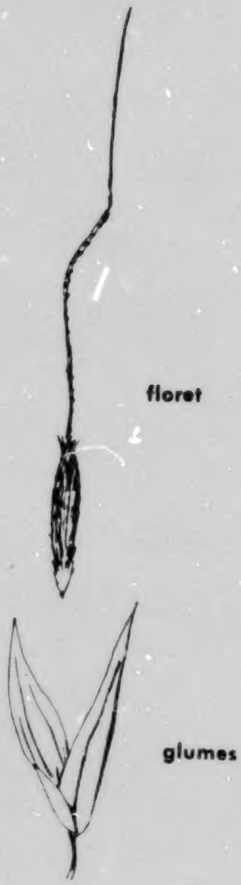
The needlegrasses are densely tufted perennial bunchgrasses with mostly fine, narrow leaves growing from 4 to 36 inches. The panicles are either narrow and erect, or open and drooping. The spikelets contain one hardened, slender floret with a long, bent, and twisted awn at the upper tip of the lemma and a sharp, hairy point at the lemma base. At maturity, the florets shatter from the long glumes and become buried in the soil.

Needlegrasses are widely found in all of the western states from near sea level to 10,000 feet. They do best on well-drained soils of foothills and plateaus at intermediate elevations. The stipas are often abundant in grasslands or within shrub and open timber stands.

Needlegrasses are considered valuable forage species since the young leaves are very palatable and the leafy crowns remain green for a long period. The foliage is grazed in the spring, summer, and fall, and retains nutritive value even when dry and somewhat tough following seed maturity. The flowering heads are often avoided at maturity and the sharp florets of some species can cause injury to the mouth and eyes of livestock. The needlegrasses regenerate readily, and plants withstand grazing well. Two western species are included here to represent this large and important genus of forage grasses.

Needle-and-thread (*S. comata*) is a slender, erect bunchgrass producing basal leaves and narrow leafy panicles from 12 to 36 inches high. The panicles are often partly enclosed by the uppermost leaf sheath. The single florets are about ½ inch long and tipped with a curving awn 4 to 6 inches long. Needle-and-thread commonly occurs with sage, juniper, and pine where it is grazed during the early spring. After flowering, the sharp lemmas and long awns become troublesome to animals. It is considered good forage.

Columbia needlegrass (*S. columbiana*) is a rather small, fine-leaved bunchgrass with very slender, narrow panicles of crowded spikelets. Florets are ¼ inch long, hairy, and have a bent awn about 1 inch long. Columbia needlegrass is good forage for all livestock, particularly cattle. This is a key forage species on closely grazed Intermountain sage-grass ranges.



Columbia Needlegrass

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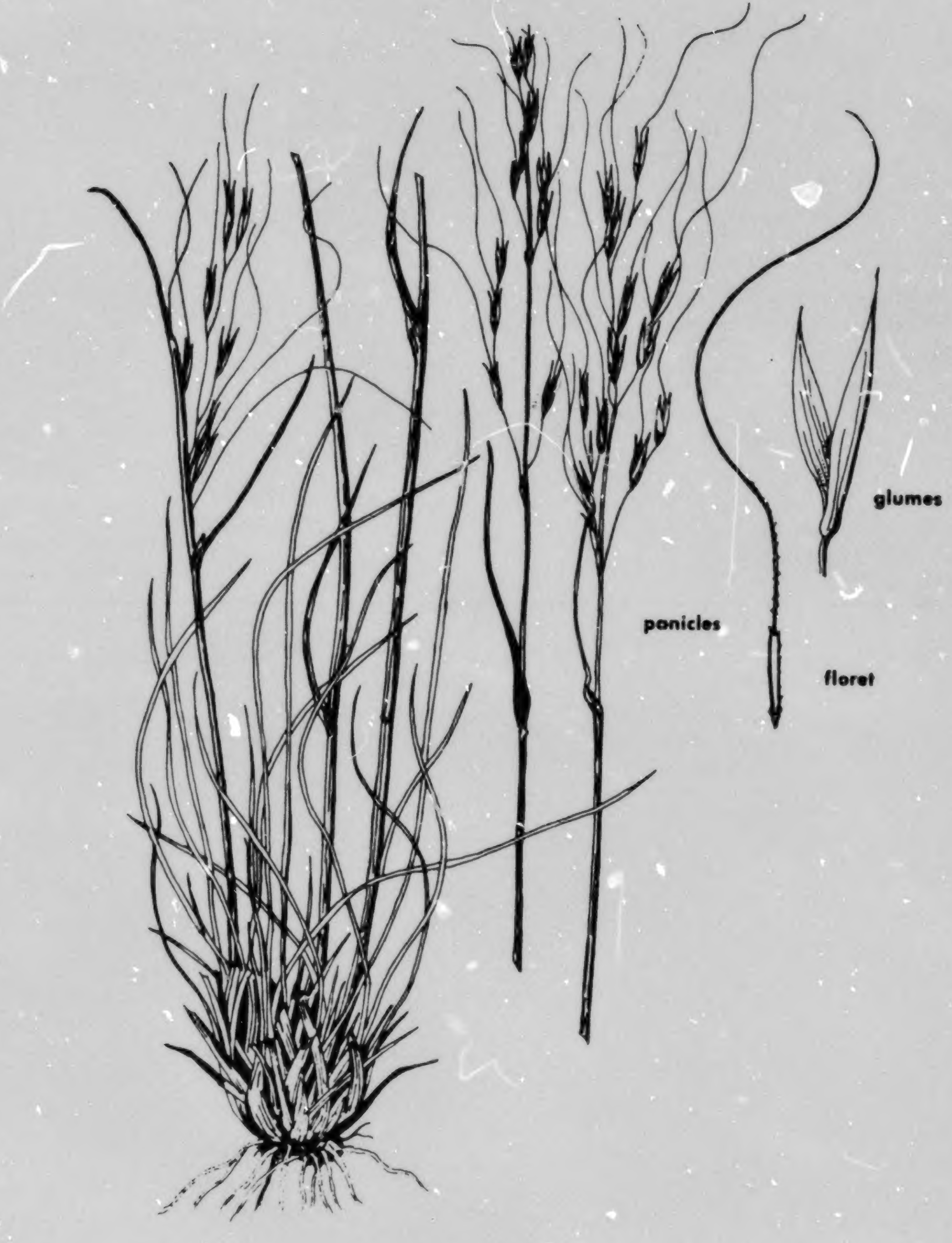

glumes
panicles
floret

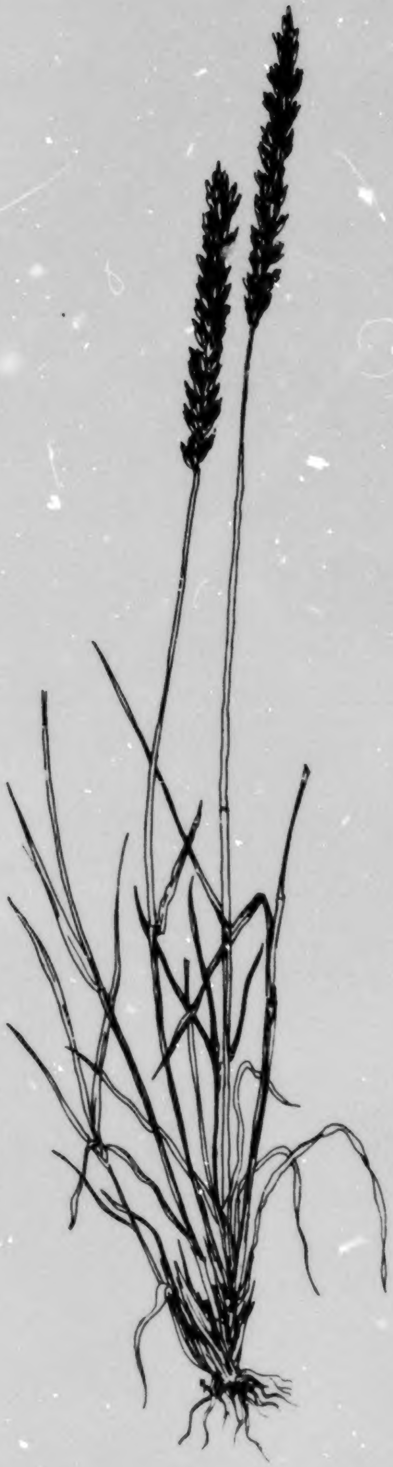
Needle and Thread

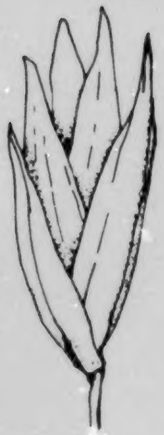
JUNEGRASS

Koleria cristata

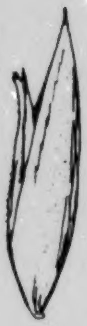
Junegrass is a perennial bunchgrass which has flat, or tightly rolled leaves. The foliage is mostly hairy. The flowering stems are 10 to 24 inches tall and bear shiny white or purple panicles that are from 1 to 7 inches long and similar to the bluegrasses. Spikelets are flattened, have two to three florets and no awns.

Junegrass is one of the most widely distributed native grasses in North America. It grows under many site conditions from sea level to above timberline. Junegrass is seldom found in dense stands, because it is a poor competitor and production of viable seed is low. Those seedlings that do survive develop slowly. Basal foliage produced in early spring is highly nutritious and is utilized by domestic and big game animals throughout the summer. Although palatability decreases after the plant has produced flowers and seed, it is readily eaten after the foliage has cured in the fall. Junegrass is generally rated as good forage.





spikelet



floret

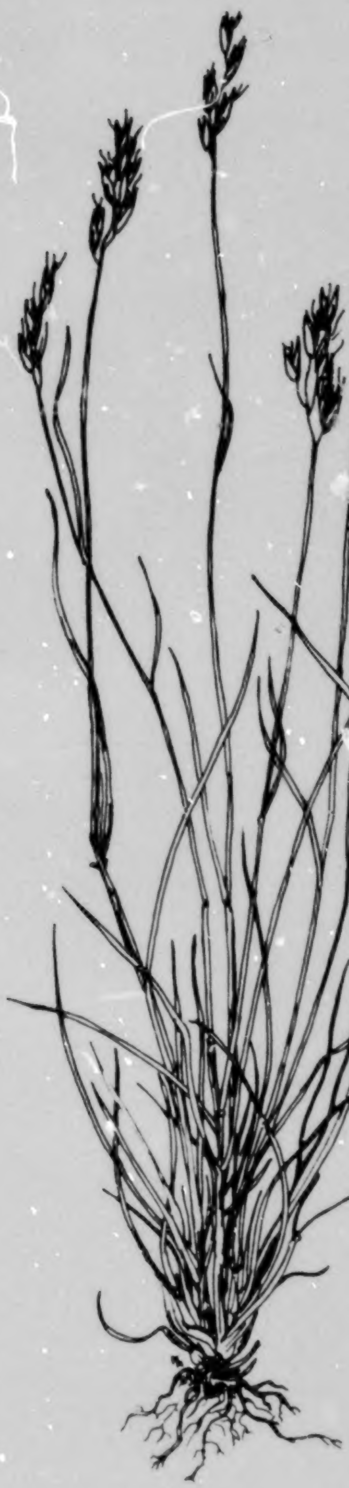
OATGRASSES

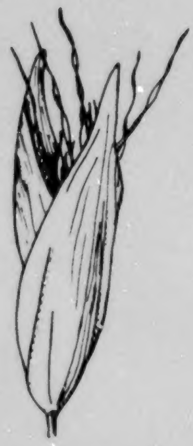
Danthonia spp.

The oatgrasses are perennial bunchgrasses with large, but few spikelets in the panicle. Spikelets have mostly five or six florets, each with a flat, twisted awn between two teeth at the tip of the lemma. The oatgrasses are unusual, since some species have additional spikelets. These spikelets may have one or more fertile florets and are borne at the nodes inside the leaf sheaths.

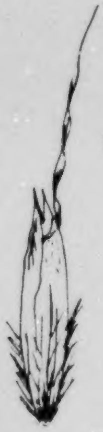
The oatgrasses grow from sea level to 8,000 feet, scattered in meadows and moist woodland-grass sites. They produce an abundance of fine, palatable foliage from the base. The oatgrasses are grazed throughout the spring and summer periods and are of high nutritional value. They are fairly resistant to grazing and are considered good forage for livestock, particularly cattle.

Timber oatgrass (*D. intermedia*) is the most common of the western species. It is a mountain grass of meadows and conifer sites. Timber oatgrass grows to 20 inches and has from five to ten purple spikelets on short pedicels.





spikelet



floret

Timber Oatgrass

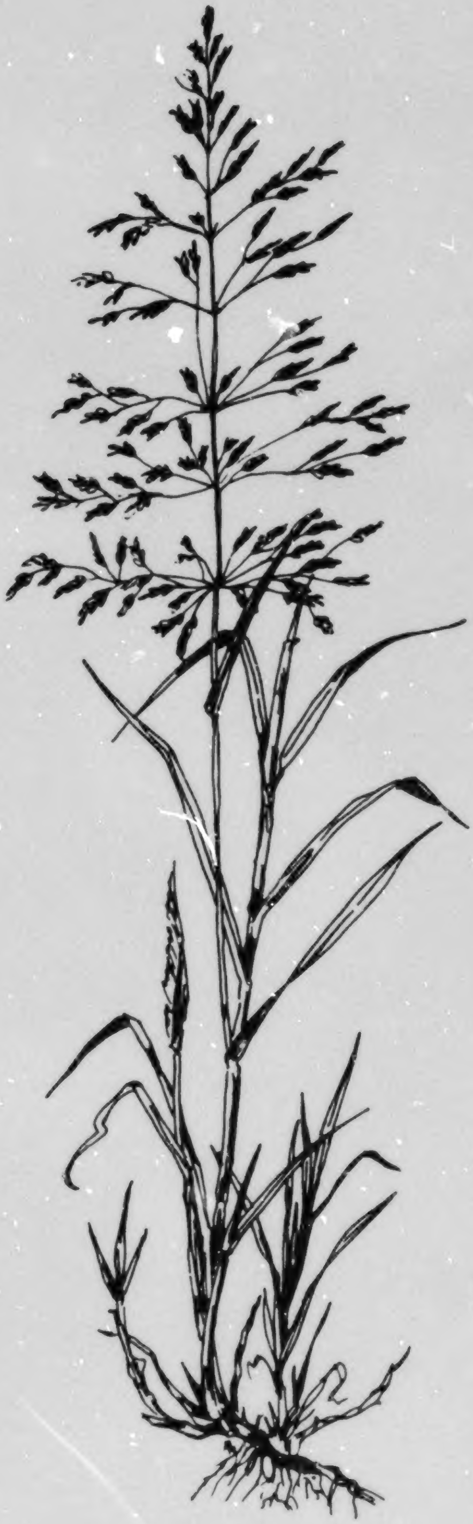
REDTOP

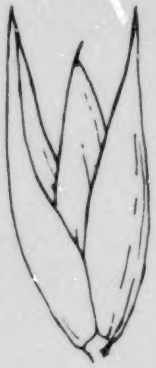
Agrostis spp.

The perennial redtops are either bunchgrasses, or sodformers called "bentgrasses." The grass has a reddish panicle that may be open in form or narrow and dense with short pedicels — closely resembling a spike. Spikelets are very small (about 1/8th inch), numerous, and bear a single floret hidden by pointed glumes. Awns are present on the florets of some species.

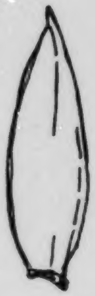
The redtops and bentgrasses are found throughout the United States and are especially common at higher elevations in the Pacific Coast ranges. They are favored by cool, moist sites of rich soils in meadows and along streams, especially in shaded locations. The forage of redtops is always good to excellent for all kinds of livestock and elk. They are a prime source of feed during the summer in mountain meadows and wooded ranges. Most withstand grazing well and some species are widely cultivated and used for reseeding suitable meadow range sites.

Two species of redtop are of great importance, redtop (*A. alba*) and spike redtop (*A. exarata*). Redtop is an introduced sod-forming grass with open panicles, while spike redtop is a native bunchgrass having narrow, spike-like panicles. Both are highly valuable range plants. Standard redtop is commonly seeded in open, wet sites for hay and pasture, often with timothy and clover.

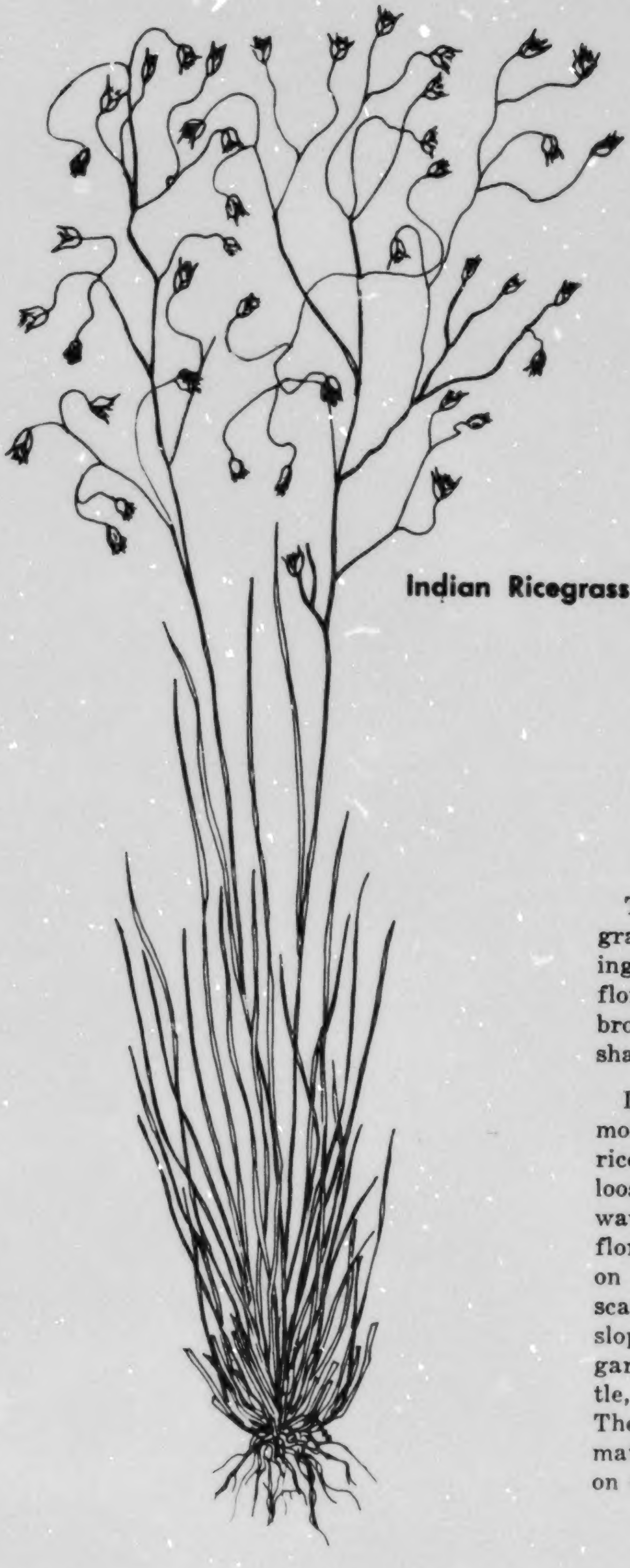




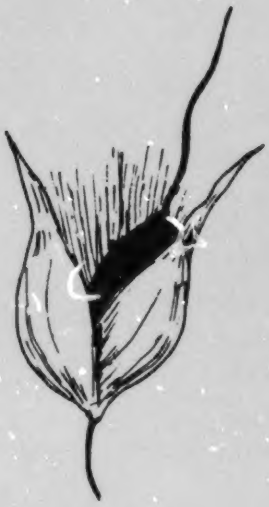
spikelet



floret



Indian Ricegrass



spikelet

RICEGRASSES

Oryzopsis spp.

The ricegrasses are perennial bunchgrasses with long leaf blades and spreading panicles. The spikelets have one plump floret with a short awn. The awn is easily broken from the lemma tip when the seed shatters from broad glumes at maturity.

Indian ricegrass (*O. hymenoides*) is the most important and widely found of the ricegrasses. It is easily identified by a loose, open panicle with spikelets on long, wavy, spreading pedicels, and black, hairy florets. Indian ricegrass is most common on dry, semidesert ranges where it occurs scattered among shrubs on sandy or rocky slopes and flats. This native grass is regarded as good to excellent forage for cattle, horses, and sheep on spring ranges. The foliage is particularly nutritious when mature and is an outstanding winter feed on desert ranges.

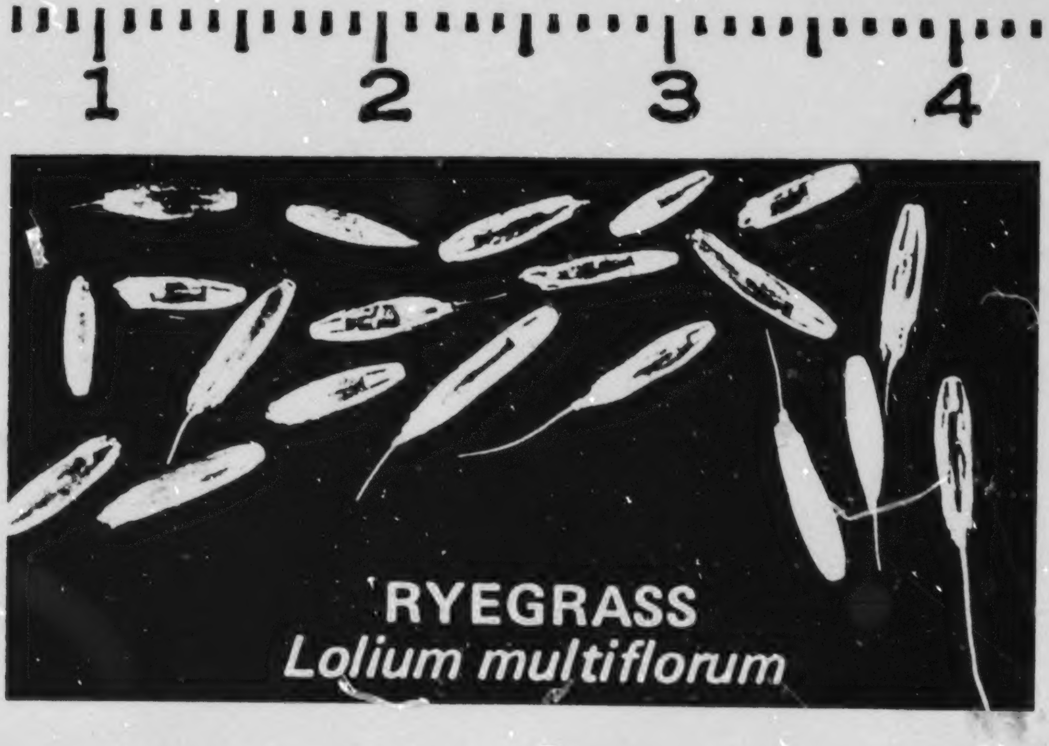
RYEGRASSES

Lolium spp.

The ryegrasses are annuals or short-lived perennials with leafy bunches of flat, shiny blades. The simple spikes are mostly 6 to 10 inches long and have evenly-spaced, flat spikelets borne "edgewise" and alternately on opposite sides of the stem. The spikelets have one glume and several florets. In some species the florets have awns.

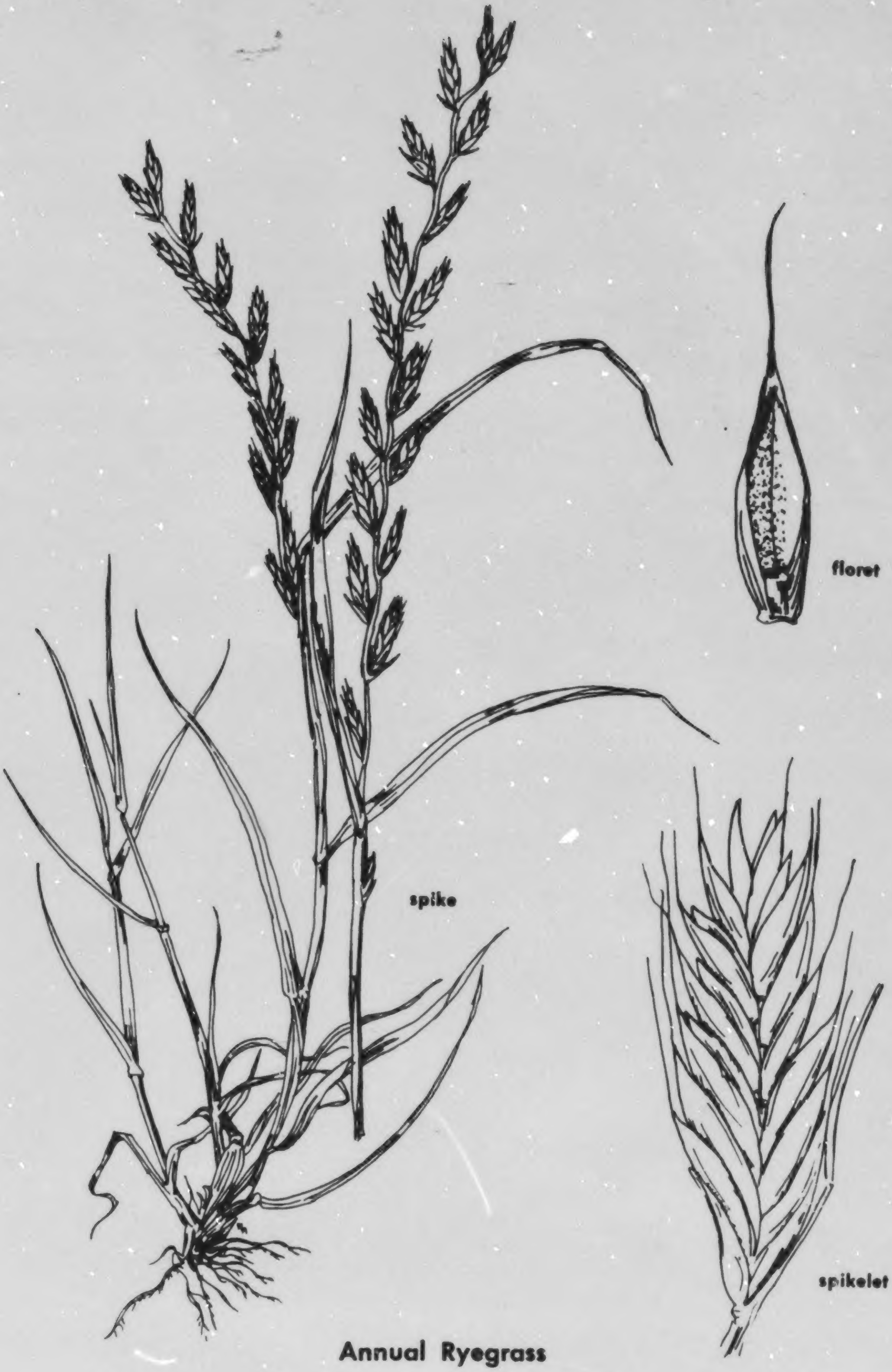
The ryegrasses were introduced from Europe and have been widely planted on the Pacific Coast ranges for forage and erosion control. They are especially well adapted for use in seeding cleared or burned-over brush ranges. All of the ryegrasses are strong competitors. Seedlings grow rapidly during the cool winter months, providing highly palatable, nutritious forage on winter and spring ranges. They are well-adapted and most abundant on clay and clay-loam soils in areas having over 15 inches annual rainfall. However, they do not persist well in coarse soils of low fertility or on drier sites. The ryegrasses are rated as excellent forage for cattle and good for other kinds of stock.

The most common species is annual ryegrass (*L. multiflorum*), also called Italian ryegrass. It is identified by the presence of awns on most or all of the florets. Annual ryegrass has adapted and spread over much of central and western California ranges where it is considered one of the best grasses in this region. Perennial ryegrass (*L. perenne*), which has awnless florets, requires more moisture than the other ryegrasses and has proven valuable for seeding on Oregon and California coast rangelands. Both ryegrasses are completely palatable as green or dry forages.



RYEGRASS
Lolium multiflorum

AgIII-XVII-100


floret
spike
spikelet

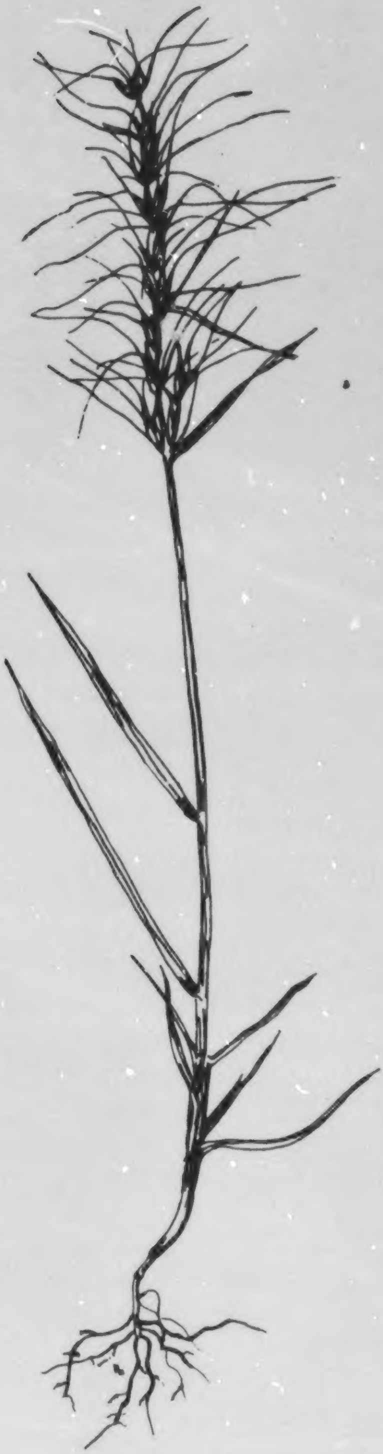
Annual Ryegrass

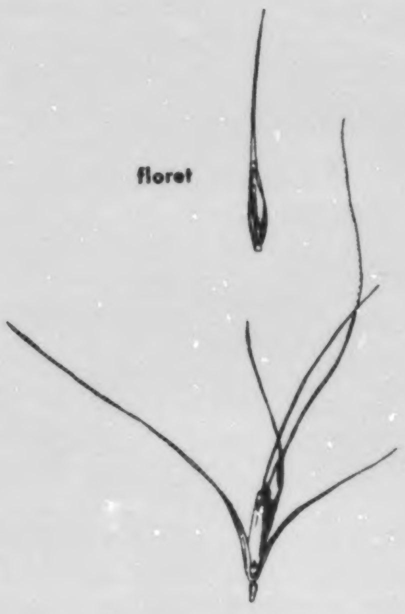
SQUIRRELTAIL

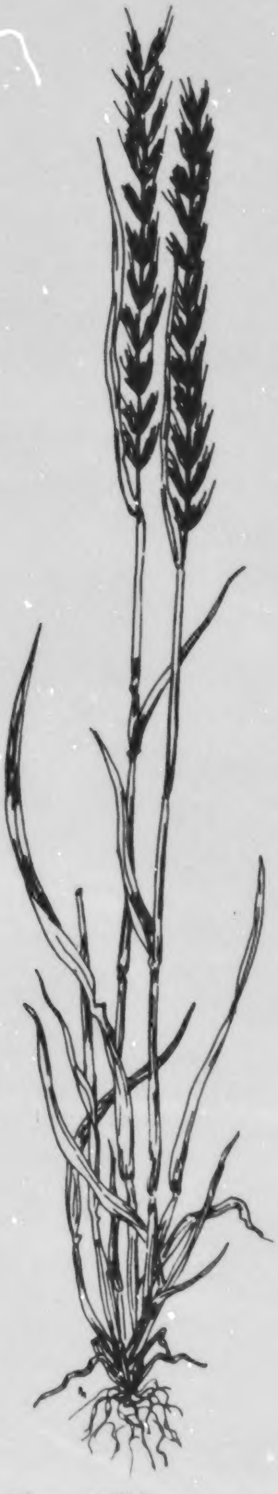
Sitanion hystrix

Squirreltail is an erect bunchgrass 6 to 24 inches tall. The foliage is sometimes bluish and sparsely hairy, the leaf blades flat or sometimes rolled. Spikelets are in groups of two, each with two to six florets with fine, long, widely-spreading, curved awns and bearded glumes. Like the barley-grasses, the spikes of squirreltail break up at maturity. The groups roll and scatter seed when blown by the wind.

This grass is found most often at intermediate to high elevations on dry sites with sage, juniper, and pine. Squirreltail is grazed by all classes of livestock although it is eaten less during seed maturity. It is ranked as fair to good forage and is a primary feed source in some areas of the Intermountain West.







Blue Wildrye

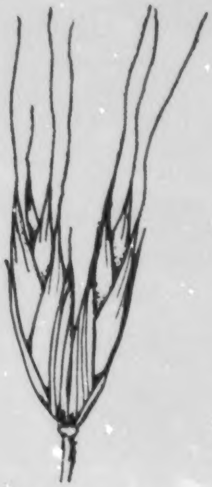
WILDRYES

Elymus spp.

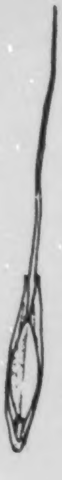
The wildryes are mostly tall, tufted or sod-forming perennials with coarse leaves. The erect spikes are narrow and long with rigid stems at maturity. The spikelets are mostly in pairs (sometimes three to six in a group) along the main stem, and each has narrow, stiff glumes. The florets are awned or pointed, depending on the species, and are in groups of two to six in the spikelets.

The wildryes are widely distributed on western ranges from sea level to over 10,000 feet elevation. Generally, they are only fair forage, particularly at maturity, because of their coarse, stemmy foliage which reduces palatability. The wildryes are most often eaten by cattle and horses.

Blue wildrye (*E. glaucus*) is perhaps the most common species. It is a bunchgrass found scattered among tree and shrub stands on moist or shaded sites. Spikelets occur in tight pairs on the spike with florets having rough, nearly straight awns up to ½ inch long. The blue-green foliage is eaten early in the spring before the unpalatable heads develop.



spikelet pair



floret

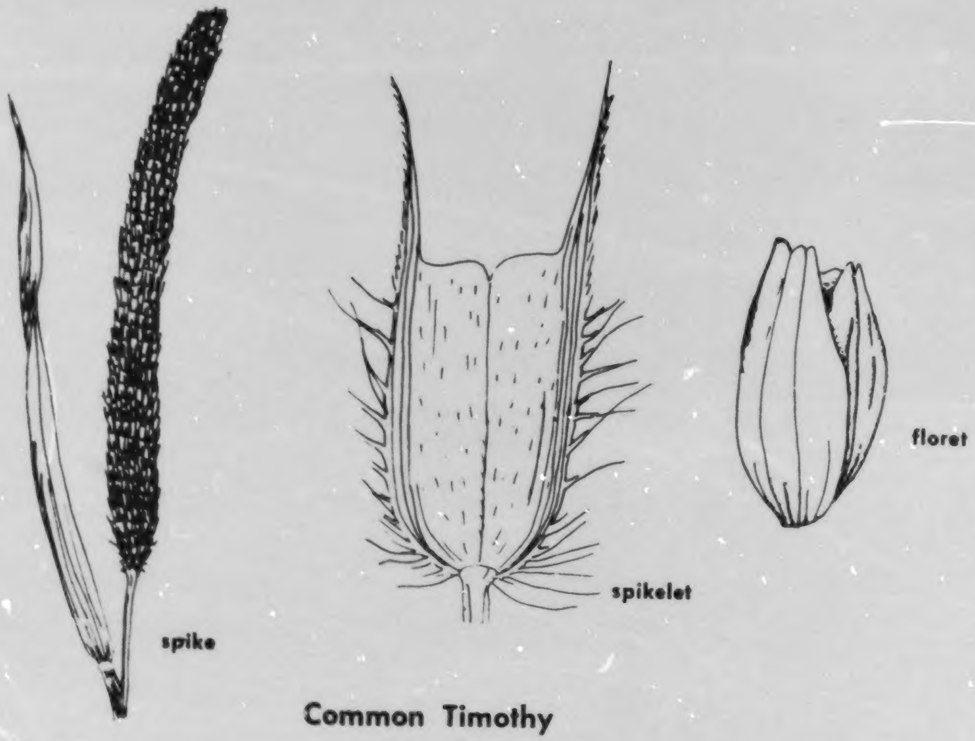
TIMOTHY

Phleum spp.

Timothy (*P. pratense*) is a perennial bunchgrass up to 4 feet in height with stems swollen at the base. Its leaf blades are flat, rather coarse, and distributed along the stems. The dense, spike-like panicle is cylindrical, about 2 to 6 inches long, and has a diameter of about pencil size. The spikelets have awned glumes with spreading, stiff hairs on their margins, and one small floret which is flattened. These features easily distinguish it from the canarygrasses.

Timothy was introduced from Europe and is popular throughout the United States as a hay, pasture, and meadow range grass. It is best adapted to the mountain climates where it grows in moist soils of meadows, stream beds, and roadsides. Timothy is commonly used to seed meadowland and other moist sites for grazing. Reseeding is done each five or six years on sites used for hay production. In mountain valleys, timothy is commonly seeded along with perennial clovers and redtop for a hay or pasture crop.

A similar species, alpine timothy (*P. alpinum*) is a native of high elevations. It differs from standard timothy by its smaller size and wider, egg-shaped panicle which is usually less than one inch long. It is also frequent in meadows and along streams. Both species of timothy are grazed during the summer and are regarded as excellent forage for livestock and big game. The dense foliage is highly palatable, but the plant loses vigor when grazed too closely.



Common Timothy

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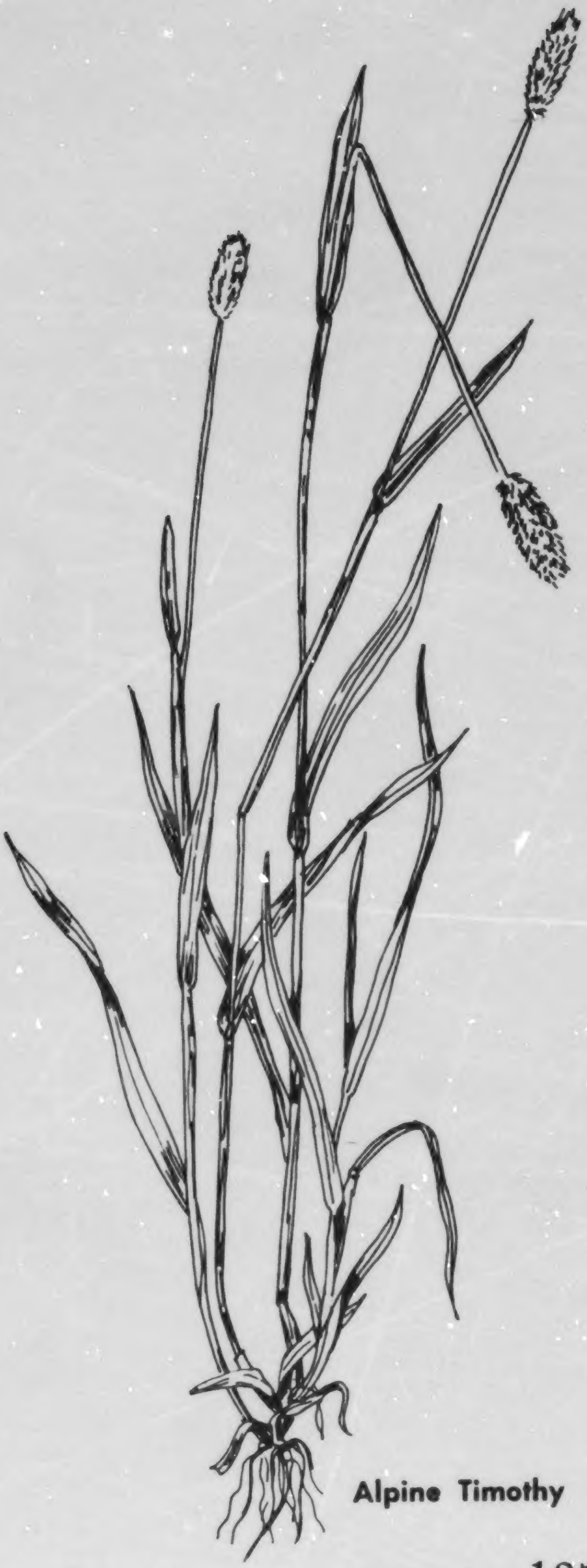
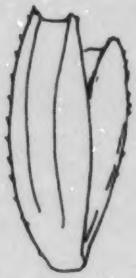
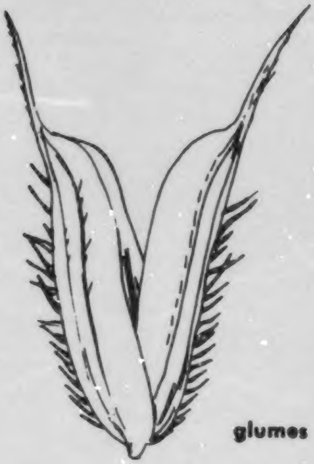


Alpine Timothy



floret



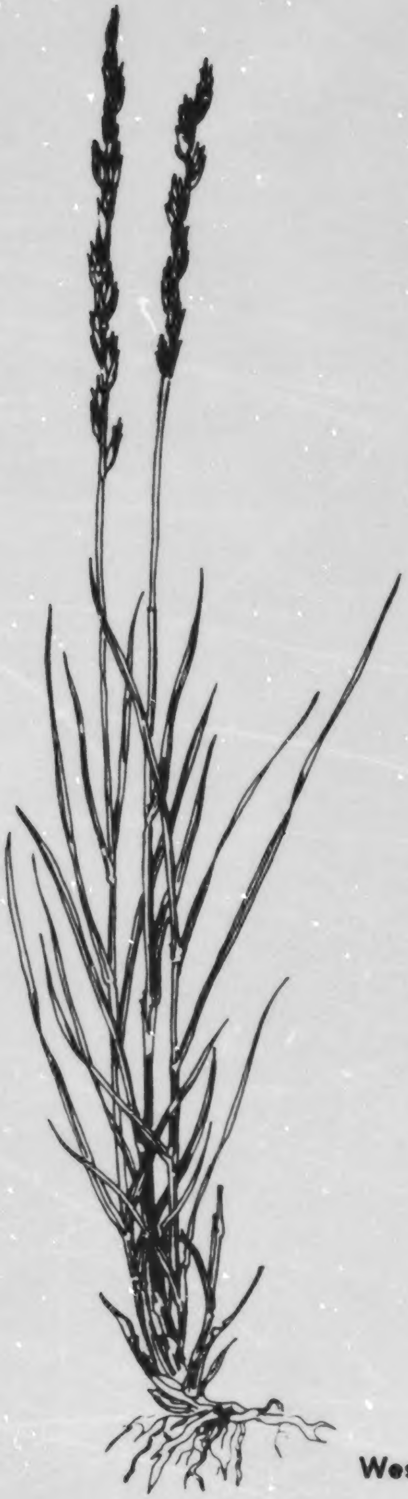
glumes

WHEATGRASSES

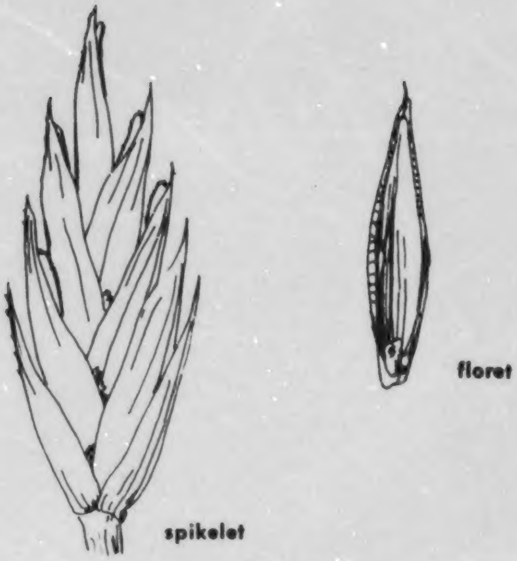
Agropyron spp.

The wheatgrasses are all erect perennials having simple spikes with evenly-spaced, flattened spikelets borne "flatwise," singly and alternately on opposite sides of the stem. Each spikelet contains three to several florets. In some species the spikelets have short awns. At maturity the spike does not break up, but the seed falls from the spikelets leaving the glumes attached to the stem. The leaves are flat or somewhat rolled and tend to be firm and roughened.

All the wheatgrasses are best adapted to elevations from 3,000 to 10,000 feet in areas having from 8 to 28 inches annual precipitation. They are common in the Intermountain states on sagebrush, juniper, and open coniferous forest ranges, and they grow in a variety of soil types.



Western Wheatgrass

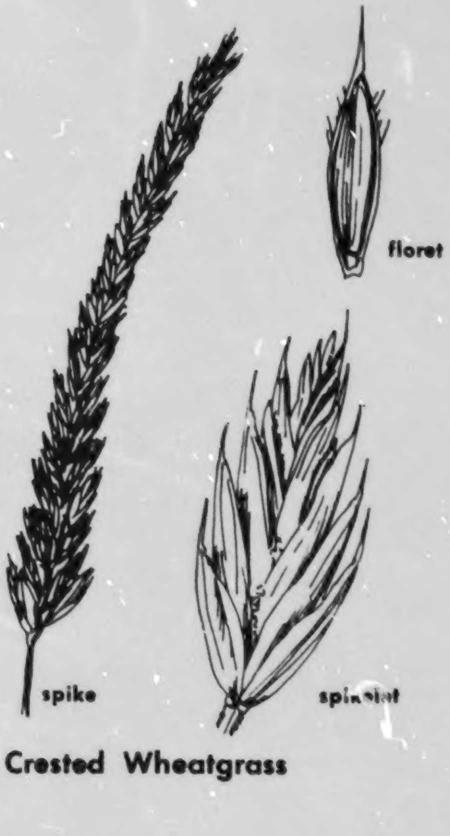


Essentially, all wheatgrasses are valuable forage throughout the year and are primary sources of forage production on western rangeland. They are of excellent palatability in the spring, especially for sheep, and make outstanding feed for cattle and horses in the summer, fall, and winter. Of the many important wheatgrasses, three outstanding species are discussed here.

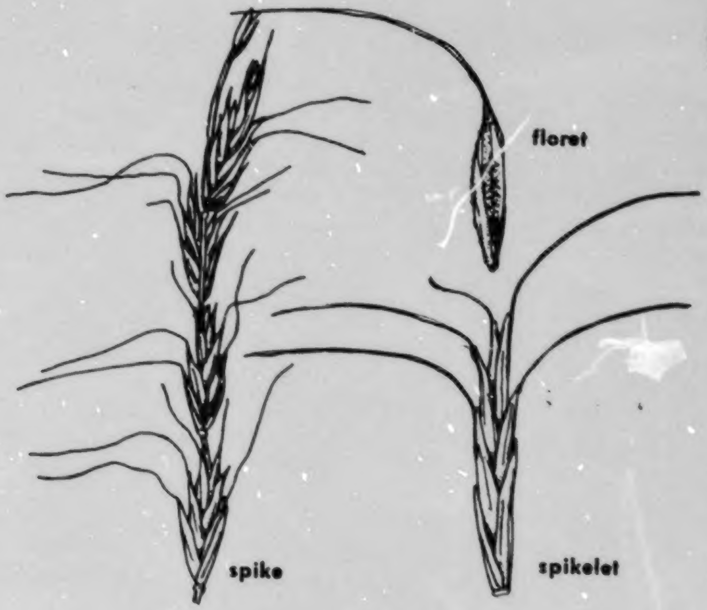
Crested wheatgrasses (*A. cristatum*) is an introduced bunchgrass which is widely used on depleted ranges and retired croplands in the northwestern United States. It has a short, dense spike of multi-flowered spikelets. The spikelets are short-awned and overlap closely. Crested wheatgrass is resistant to cold and drought and is especially useful for spring grazing. It is fine-stemmed and higher in nutritive value and palatability than most wheatgrasses.

Bluebunch wheatgrass (*A. spicatum*) is one of the most important native perennial wheatgrasses because of its wide distribution and high forage value. The spikes are rather long and slender, and the spikelets do not overlap. There are three to six florets having curved awns about one inch long. Bluebunch is most common on dry slopes and is excellent forage for cattle and horses, particularly late in the season.

Western wheatgrass (*A. smithii*) is an erect, sod-forming native perennial. The grass has blue-green, rough foliage and a long, slender spike. Spikelets overlap with several, awn-tipped florets. This grass is found in all the western states. Although western wheatgrass does best on moist or alkaline bottomlands, it is also found on other soils. It makes rapid growth in early spring and is rated as good forage for all livestock.



Crested Wheatgrass



Blue Bunch Wheatgrass

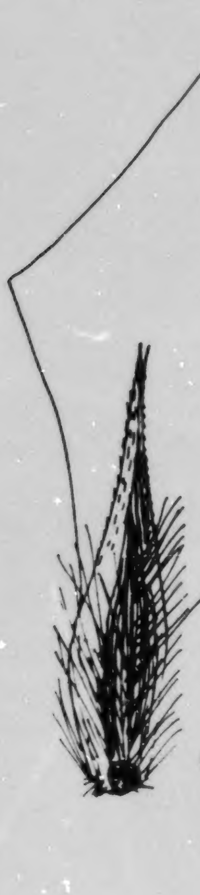
WILDOATS

Avena spp.

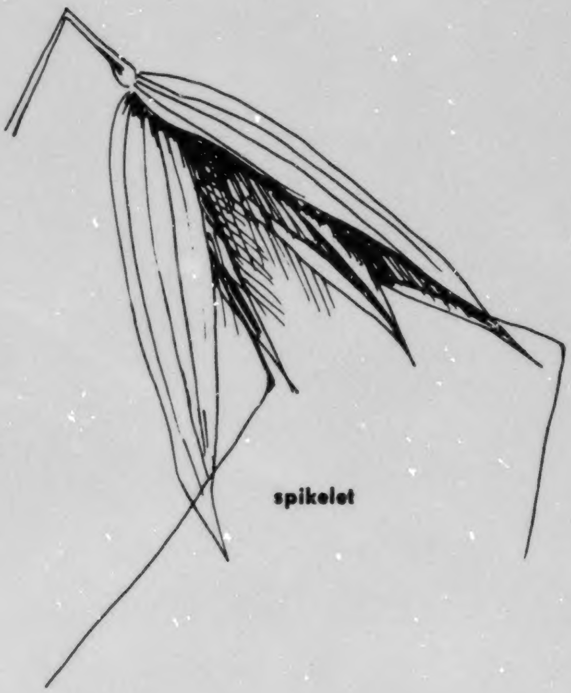
Wild oats are erect annuals 12 to 36 inches high, with flat, rather broad leaves having large ligules. The open panicle has large, drooping spikelets, each with glumes enclosing two or three hairy florets with long awns. The awns are borne at the middle of toothed lemmas and are tightly twisted above the base and then sharply bent. The florets readily fall from the glumes at maturity.

Two primary species, common wild oat *(A. fatua)* and slender wild oat *(A. barbata)* were introduced from the Mediterranean region into California and now grow over much of the state below 5,000 feet elevation. They are particularly abundant in valley and foothill grasslands on more productive sites having a history of light grazing. Wild oats, generally rated as good forage, produce abundant, nutritious foliage and seed heads through the winter and spring periods. At maturity, however, fiber content increases rapidly, leading to reduced value and palatability after the seed is cast. These grasses depend on a large crop of seed for their existence and do not persist under continued grazing pressure.

Common wild oat is the principal species in the western states. It occurs on heavy or medium textured, fertile range soils, and is frequently a troublesome weed on grain and haylands. It is distinguished from slender oat by its coarse appearance and lemmas with deep brown hairs and shorter teeth at their tips. Spikelets (glumes) are nearly one inch in length and are attached to the stem by long, stiff pedicels.

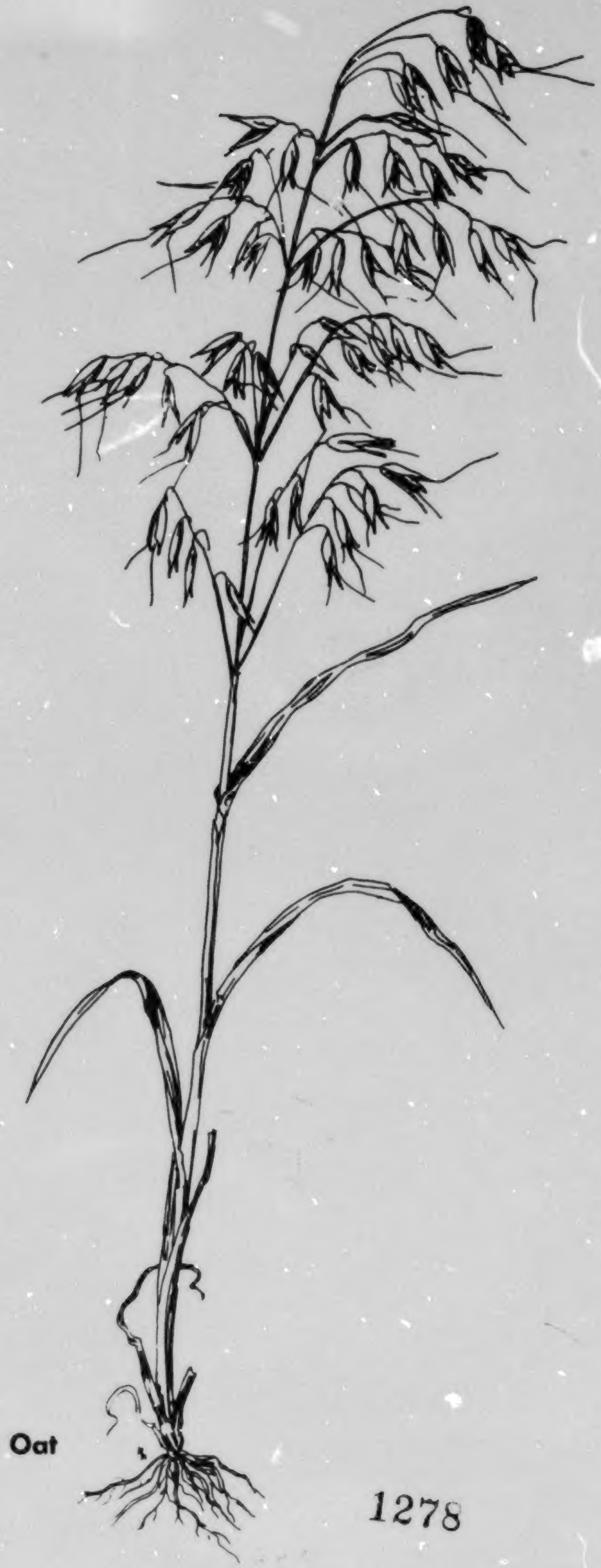


floret



spikelet

AgIII-XVII-108



Wild Oat

1278

Appendix B

GRASS-LIKE PLANTS

Structure

Grass-like plants are named because of their similarity to grasses but belong to other families and upon close examination differ from grass in their floral parts and foliage. The sedges (family *Cyperaceae*) develop spikelets but have a single bract or scale around the flower and the ovary matures into a 3-angled or lens-shaped fruit. In rushes (family *Juncaceae*), the flowers are borne singly and are surrounded by six dry bracts. Their fruit is a leathery capsule which splits, releasing numerous small seeds. The stems of both sedges and rushes are not jointed and are pithy. Their leaves are primarily arranged on the stem in three ranks, or two in some species. Most grass-like plants are perennials which develop coarse, creeping rootstocks.

Growth and Value

Grass-like plants grow in a variety of sites from sea level to timberline but are concentrated in moist or wet soils in mountain flats and valleys or along streams, ponds, and lakes. Only a few species are important on dry sites. As a group, the grass-like plants are most common and important in meadows at higher elevations where they are often the most common forage available.

The grass-like plants are rated fair to good forage for livestock and big game. Cattle often wade to graze new growth in the early spring, and in the fall when other range species are dry, both cattle and sheep relish the green foliage of sedges and rushes. Little is known of their nutrient value, but it is assumed to be similar to the grasses. Some studies have indicated that they are higher in protein.

Grass-like plants can tolerate close grazing and trampling since their rootstocks are protected under the soil. Reseeding of mountain sites with grasses following cultivation often results in rapid regeneration of the native grass-like plants. Probably because of surviving rootstocks as well as fertile seed remaining in the soil.

Two kinds of grass-like plants are most common on our ranges. Each represents its family and takes the same name.

Descriptions of Important Grass-like Plants

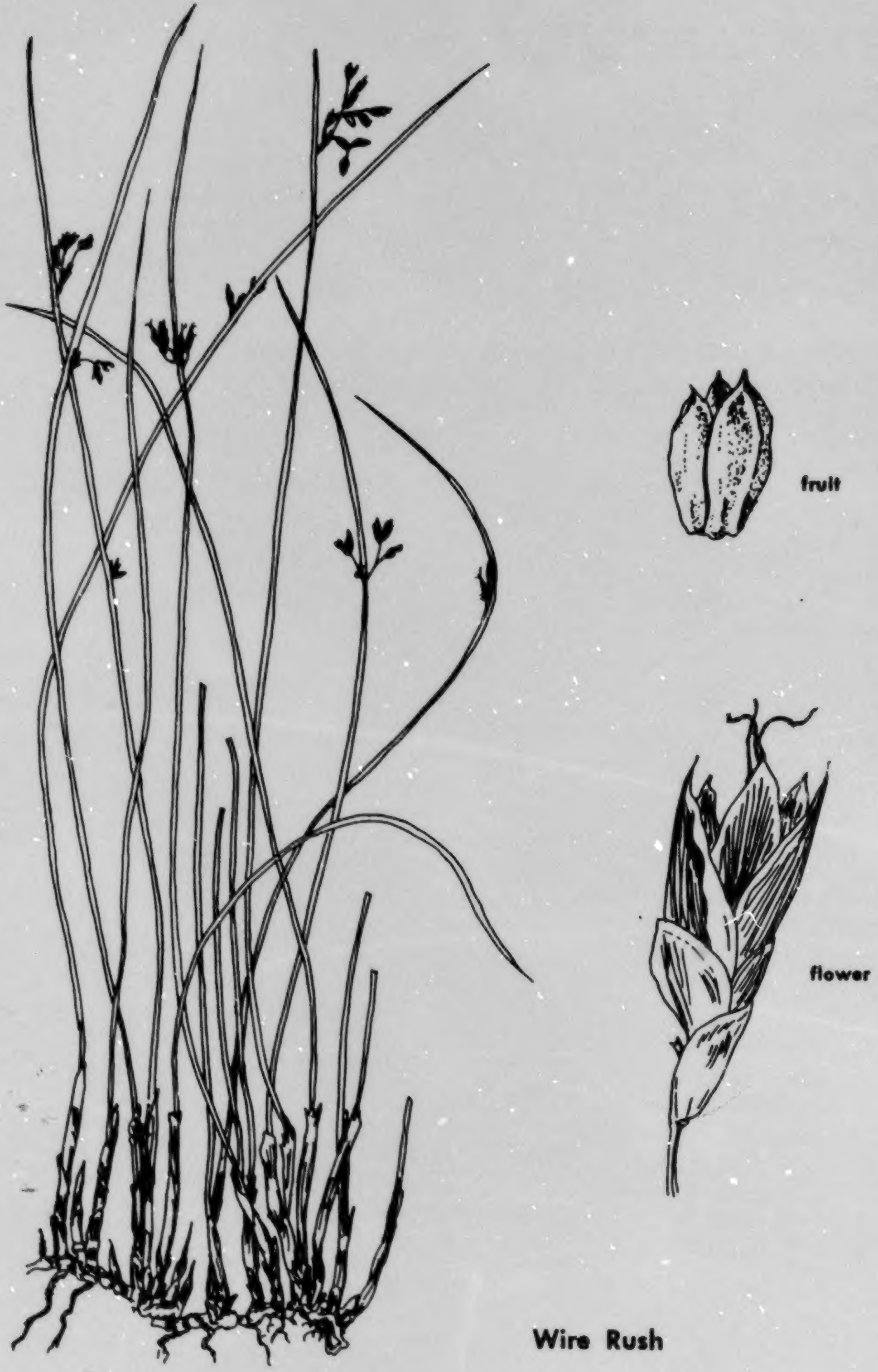
RUSHES

Juncus spp.

The rushes are the largest group in their family. The stems are simple or branched, and leaves vary widely from nearly round to flat. Flowers are borne in clusters or open groups at the tips or sides of the stems. The fruit is a capsule which splits at maturity to release several seeds.

Wire rush (*J. balticus*) is by far the most important forage rush in the West. Leaves are simply sheaths from the plant base. The wire-like stems bear a loose cluster of brownish flowers below their tips. This rush grows on a wide variety of sites at all elevations, but prefers moist or wet, rich soils. Palatability of wire rush is greatest in the spring and declines as the tough stems mature. Forage value is generally good since the plant is high in protein and closely grazed by cattle, particularly when scattered in meadow grasslands.

AgIII-XVII-110


fruit
flower

Wire Rush

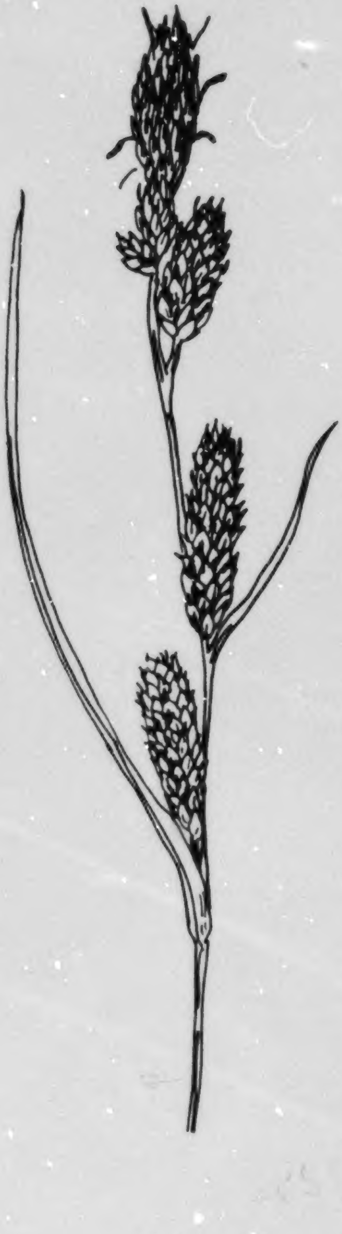
SEDGES

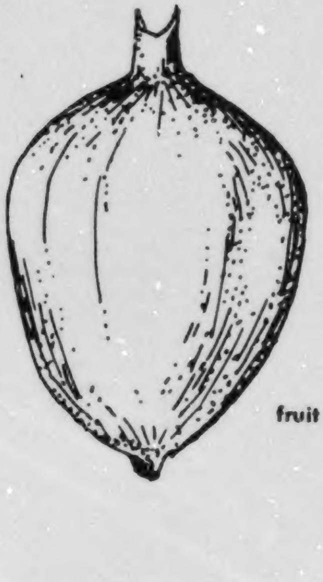
Carex spp.

The sedges are an extremely large group of tufted or sod-forming perennials native to the United States. Leaf blades of the sedges are mostly long and slender, flat or folded, and greenish-brown. The seed head consists of several spikelets, mostly grouped into a simple or branched spike near or at the end of the stem. Individual flowers are either male or female, both present on the same plant. Fruits are triangular or lens-shaped and fall from the spikelets at maturity.

Nebraska sedge (*C. nebraskensis*) is one of the most common western species found mainly on wet sites of the Intermountain area. The triangular stalks are from 1 to 3 feet tall and bear long, pale green leaves about ⅜ inch wide. Spikes are branched, each above a leaf blade on the upper stem. Cattle like the plant in the spring, and as the soil dries, both sheep and cattle graze it during summer and fall.

Elk sedge (*C. geyeri*) is the most abundant of the few dry-land sedges. It is found on well-drained soils in grass lands and open timber of the northwestern range states. The slender spikes have few flowers and are at the tips of triangular stems. Leaves and stems are usually less than 1½ feet tall. Palatability varies from fair to good for livestock and big game.





Nebraska Sedge

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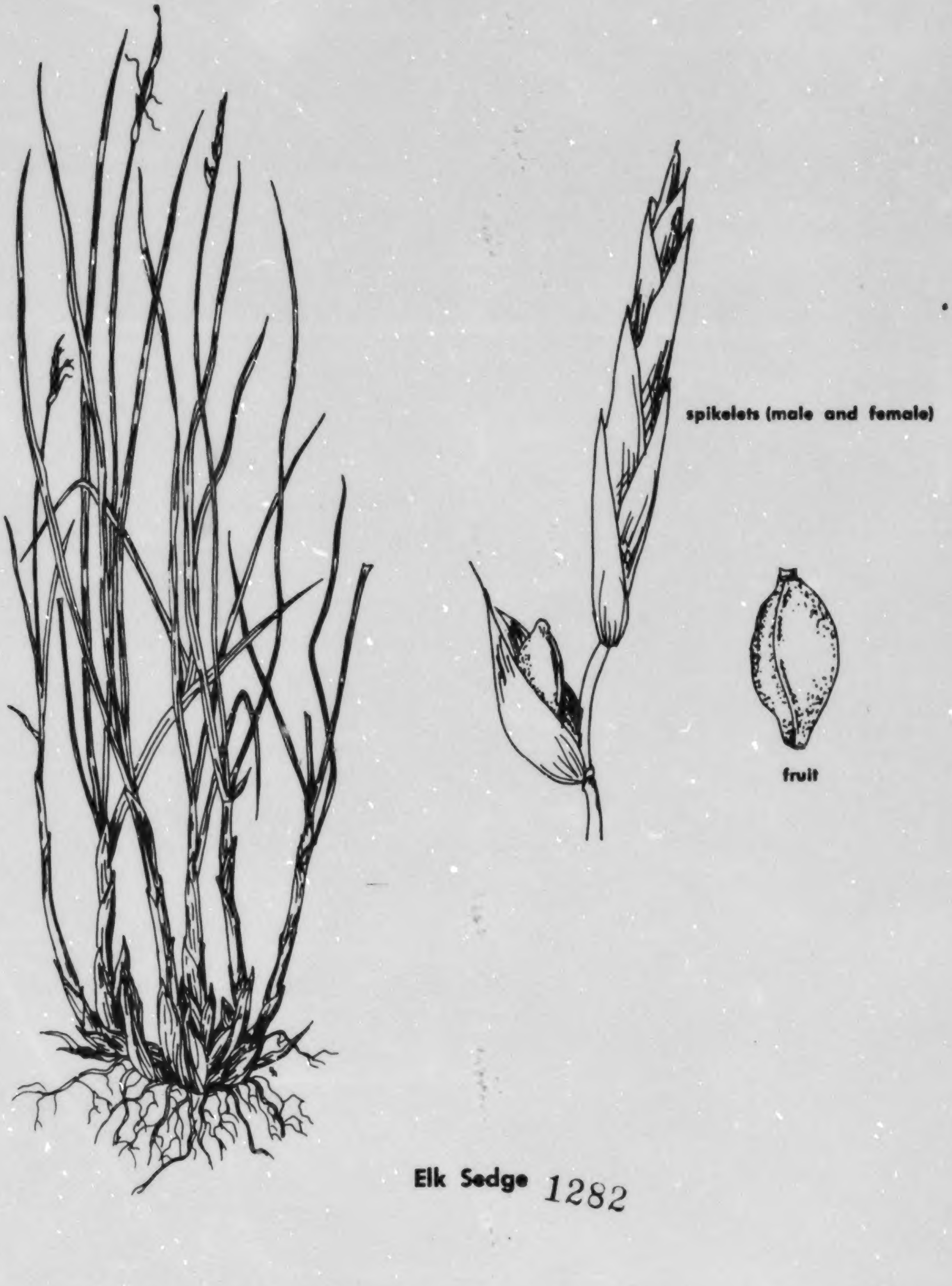

spikelets (male and female)
fruit

Elk Sedge 1282

Appendix C

DESCRIPTIONS OF IMPORTANT RANGE LEGUMES

DEERVETCHES

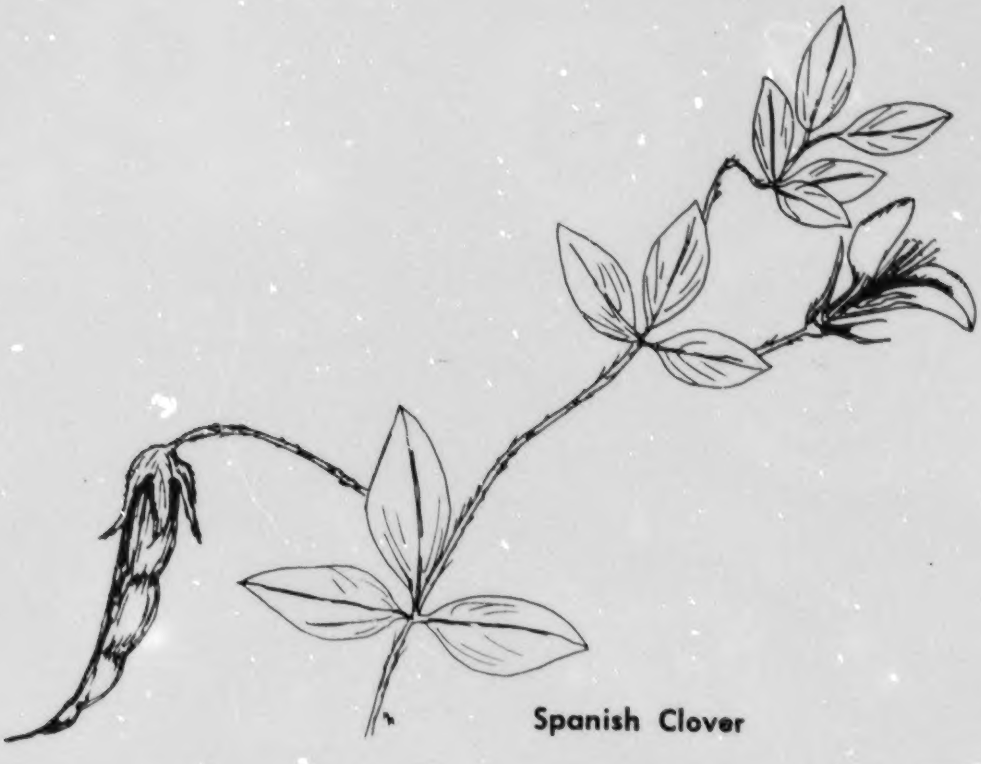
Lotus spp.

The deervetches are also known as lotus, wild trefoils, and other common names, depending on the species. They are mostly annual or perennial, low-growing herbs although some are shrubby. The leaves consist of a few smooth-edged leaflets borne at different points on the stalk. Flowers are few, yellowish, and often have rose or purple marks. They are usually borne singly, or in small loose clusters. The seed pods are narrow, have several seeds, and are sometimes flattened.

The deervetches are commonly scattered on many kinds of sites at low to intermediate elevations in all of the western states. Active growth takes place during the late spring and summer. They are highly nutritious but are of only moderate palatability to livestock and big game. Their forage value is usually ranked as fair to good.

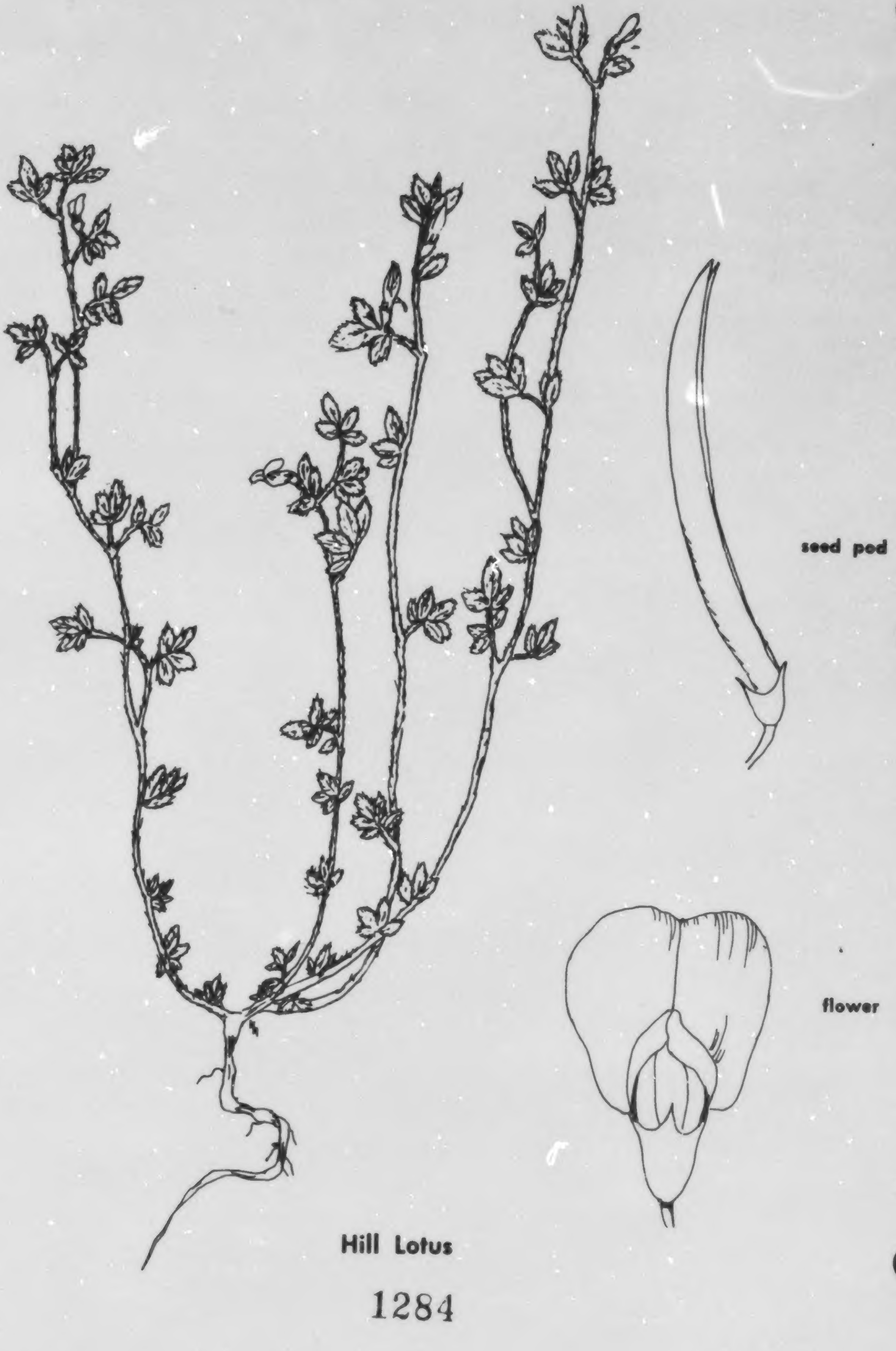
Hill lotus (*L. humistratus*) is a small annual deervetch with stems from 4 to 12 inches long, each bearing compound leaves with three to five leaflets. Small yellow flowers are borne singly among the leaves. Pods are 1/3 to 1/2 inch long. Hill lotus is mostly a plant of the southwestern foothill ranges.

Spanish clover (*L. purshianus*) is a more erect, larger annual deervetch with foliage and flowers similar to hill lotus, but with pods from ½ inch to 1 inch long. It is widely found in the western states.



Spanish Clover

AgIII-XVII-114


seed pod
flower

Hill Lotus

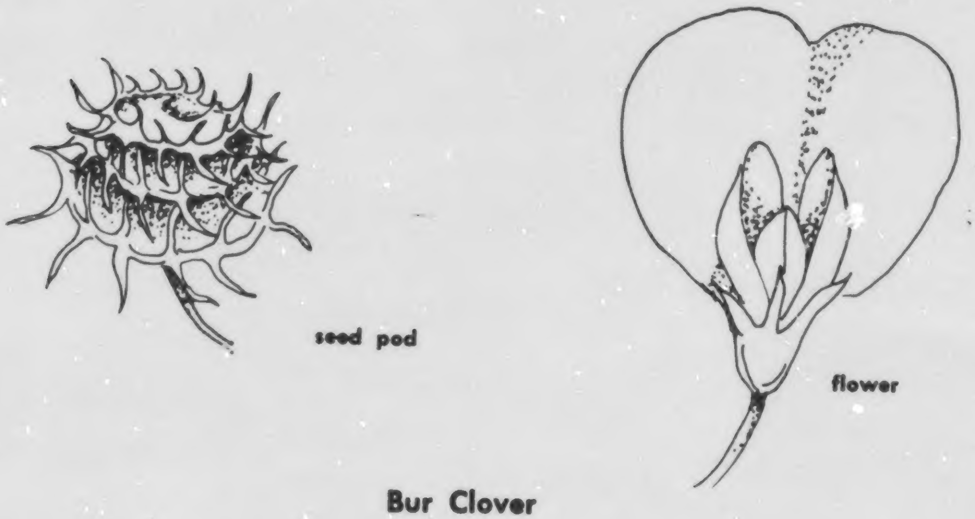
MEDICKS

Medicago spp.

The medicks are best known by alfalfa (*M. sativa*), which is perhaps the most important forage legume in the United States. The medicks are low-growing, yellow-flowered annuals except for the erect, blue-flowered alfalfa which is a perennial. The compound leaves consist of three leaflets with toothed edges or margins. The center leaflet is on a longer stalk. The seed pods are coiled, and in some species have soft, hooked spines.

Without exception, the medicks are excellent forage plants of very high palatability and nutritional value. The annuals are widely found in the southwest and on the Pacific coast, and are especially abundant in California. They are adapted to a wide variety of sites, mainly at lower elevations.

Bur clover (*M. hispida*) is an introduced winter annual medick of great importance. The leaves are smooth and hairless, consisting of broad, toothed leaflets indented at the tips. Deep, yellow flowers are borne in small groups on the stems and develop into coiled, bur-like pods with hooked spines. The foliage is close to the soil and the branched stems are often 12 inches long. Bur clover is resistant to grazing and is even favored by it, because grazing removes taller competition and aids in dispersal of the seeds.

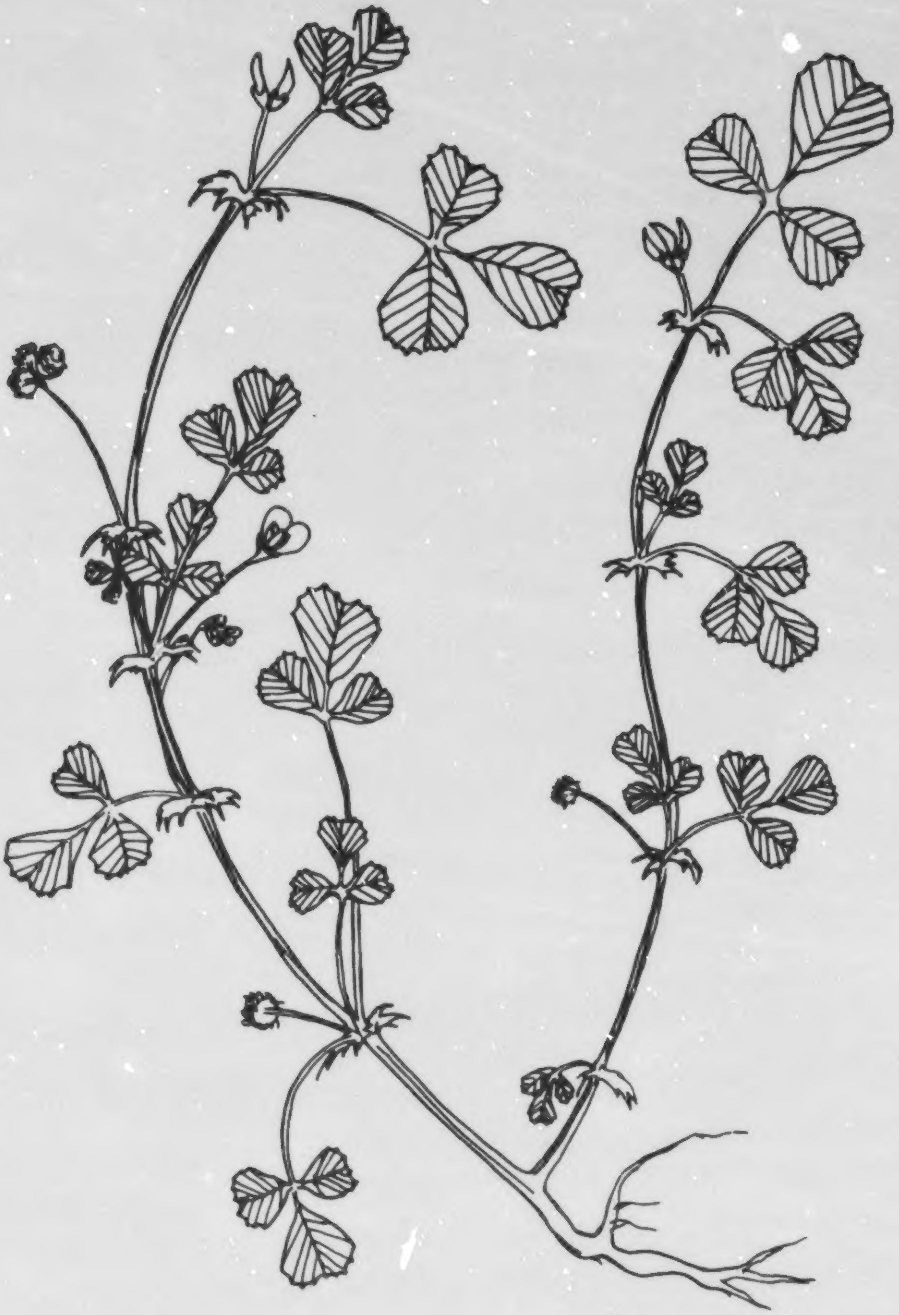


seed pod

flower

Bur Clover

AgIII-XVII-116

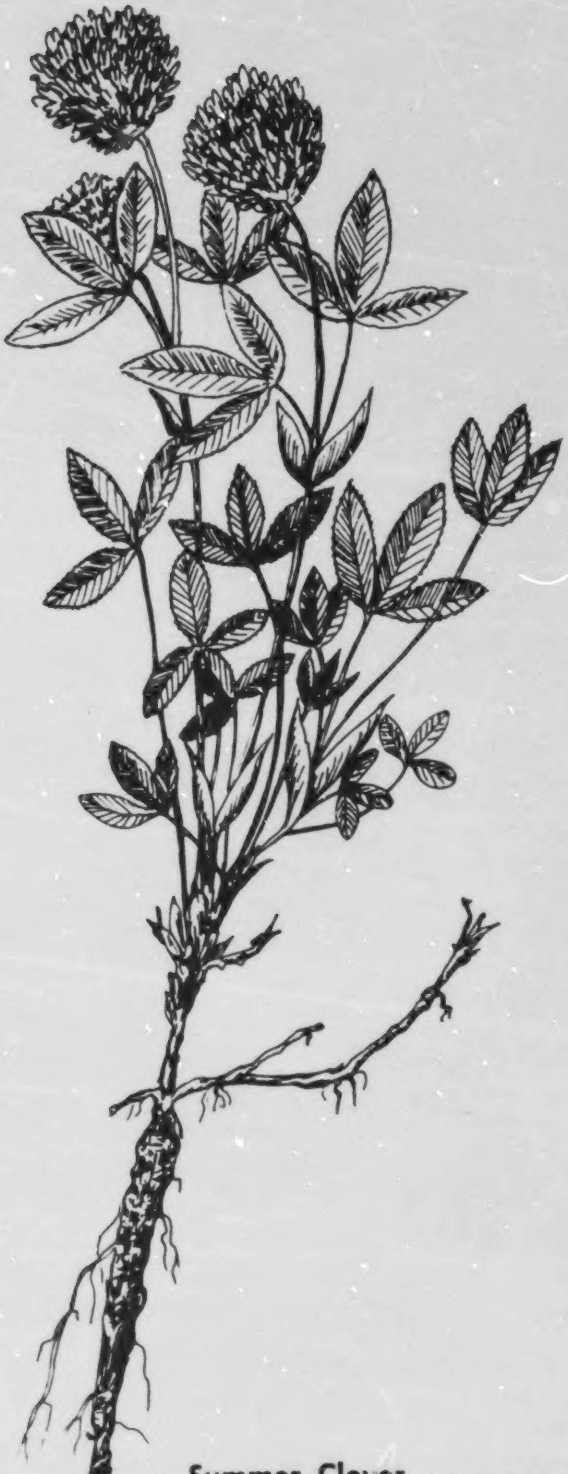


Bur Clover

1286

TRUE CLOVERS

Trifolium spp.



Summer Clover

The true clovers are important annual or perennial forage plants, both native and introduced. All have compound leaves of three rounded leaflets attached to one central point on the stalk. Flowers are in compact heads and retain their petals at maturity. The pods are one or two seeded, small, and slightly rounded.

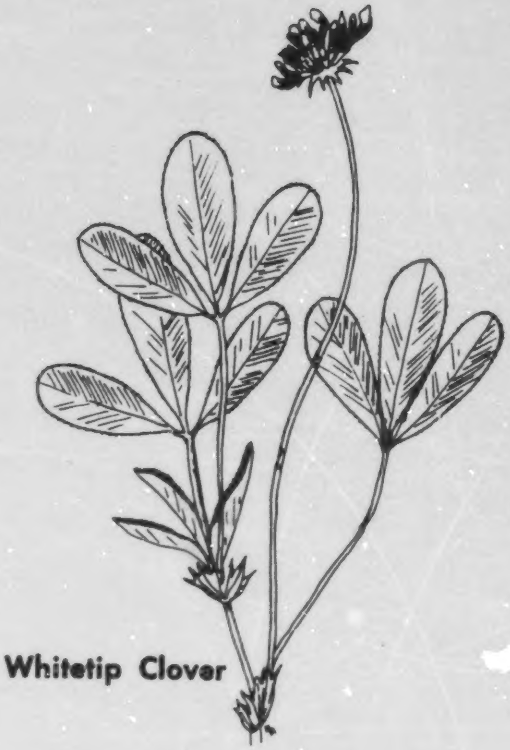
Species of true clovers are found in every range state at most elevations although they are better known on land cultivated for pasture and hay. The perennials are mostly adapted to meadow sites in rich soils. The annuals are more common on dry rangeland.

As a group, the true clovers are of excellent palatability, but those without hairy foliage and those found on moist meadow sites are best. Cattle and sheep eagerly graze the foliage and seed heads whenever available. For this reason, the erect annuals have little resistance to grazing pressure. Sod-forming perennials withstand grazing well.

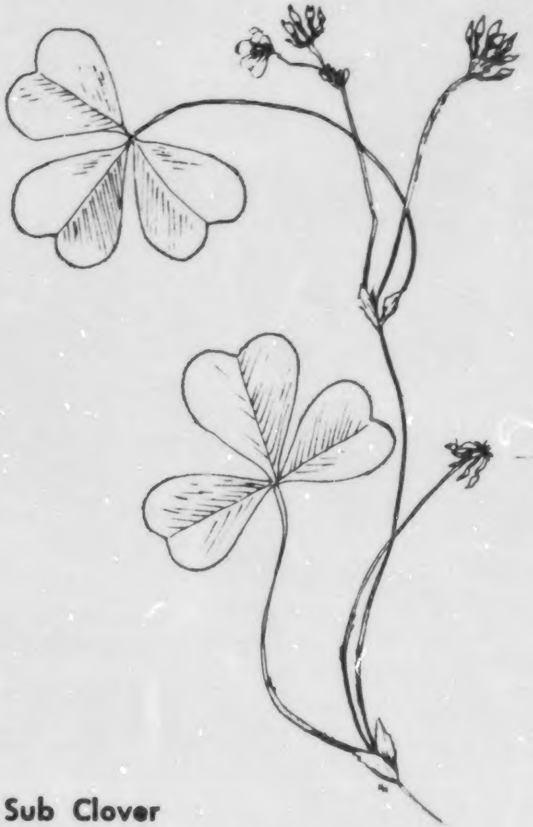
Whitetip clover (*T. variegatum*) is typical of the native annuals which are small and grow from a central tap root. They make their growth in late winter and spring. Whitetip clover has smooth foliage and heads of light purple flowers tipped with white. It is common up to 8,000 feet, especially on more moist sites.

Summer or long-stalk clover (*T. longipes*) represents the native perennials which form a sod. They are common in mountain meadows and moist flats. Flowers of summer clover are white or purple. Leaflets are smooth on the top, and hairy beneath. These perennials are green and grazed throughout the summer.

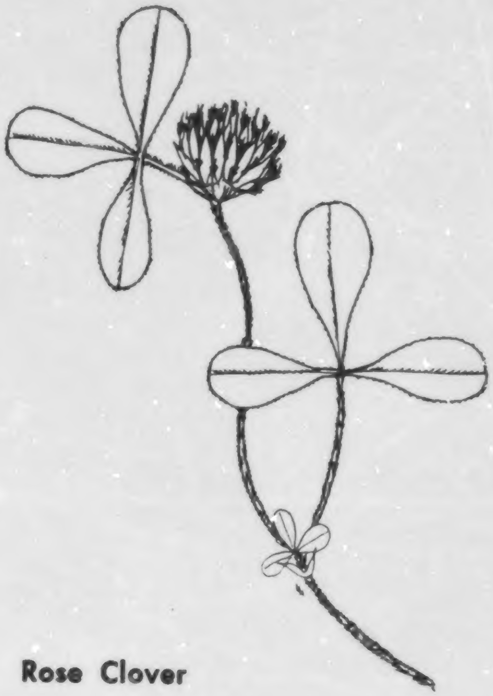
Rose clover (*T. hirtum*) and subterranean clover (*T. subterraneum*) are introduced annuals adapted at lower elevations on clay or loamy soils of the Pacific Coast states. Rose clover is densely hairy, erect, and has pink, erect flowering heads. Subclover is sparsely hairy with long, creeping stems which bear small groups of white flowers, each burying their seed under the soil. This gives sub clover good resistance to grazing. Both clovers have been of great value for seeding worn-out croplands and provide valuable forage during the winter and spring. Rose is grown better on drier foothill sites; sub clover on bottomlands having more available moisture.



Whitetip Clover



Sub Clover



Rose Clover

VETCHES

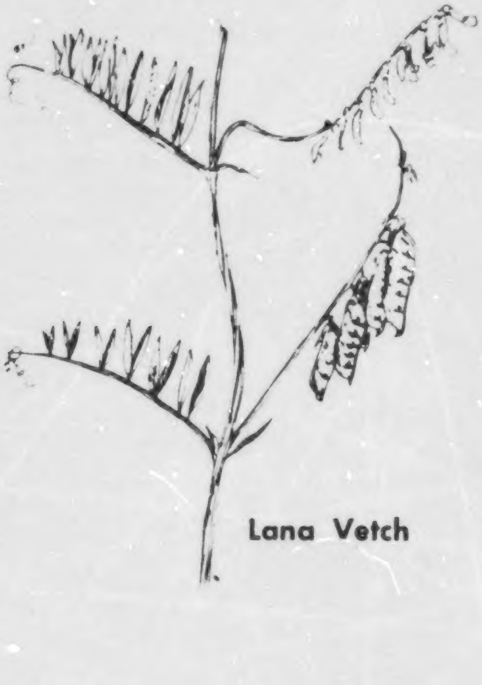
Vicia spp.

The vetches are either annual or perennial plants. They are characterized by even-numbered leaflets borne on angular stalks which end in a tendril. The life form of the plants may be spreading or climbing. The flowers are usually blue or purple in most species. Pods are flat and usually contain several seeds. The vetches are frequently mistaken for the wild peavines (*Lathyrus* spp.) which have essentially the same features.

The range vetches include both native and introduced species. All of them are palatable, at least during the later stages of growth. The native species are widely distributed at foothill and mountain elevations, but are rarely abundant. The introduced vetches have been cultivated for hay, or seeded for soil improvement and pasturage — usually on lower valley and hill ranges. Most vetches are rated as fair to good forage for all classes of stock and big game.

American vetch (*V. americana*) is probably the most common of the native vetches. It is a perennial with three to ten blue flowers in each cluster and the seed pods are about 2 inches long. This vetch occurs in grasslands and open timber sites, and it is so highly palatable that it is frequently over-grazed.

Lana, or woolypod vetch (*V. dasycarpa*) is an introduced annual having ten to 40 violet-colored flowers and slightly hairy foliage. The seed pods are about one inch long. This vetch has been seeded on marginal croplands and foothill ranges for erosion control and summer grazing. It is considered to be of fair to good forage value.



Lana Vetch

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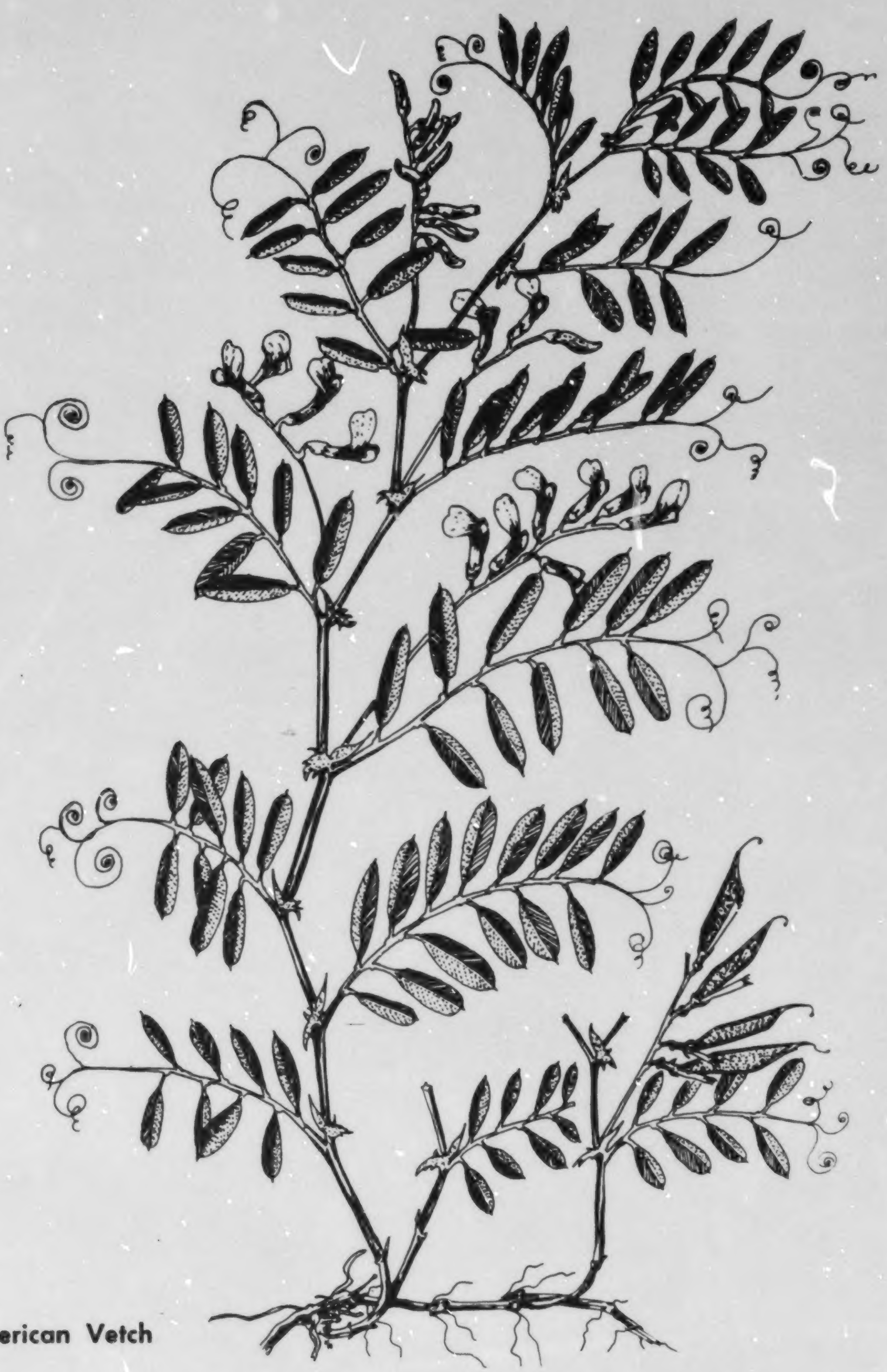

American Vetch

Appendix D

DESCRIPTIONS OF IMPORTANT RANGE FORBS

BUTTERCUP

Ranunculus spp.

The buttercups are annual or perennial herbs. They have alternate leaves which are simple, or divided by pointed lobes. Flowers have from five to fifteen bright, shiny yellow petals, borne at the ends of the branches.

The buttercups are plants of moist or wet sites and begin growth very early in the spring. Many species are widely distributed in mountain meadows and stream banks of the West and are also found in low areas or moist slopes in the desert and coast ranges. The very early foliage is disliked by livestock and by mid-summer plants have died back to the soil surface. So, the buttercups are considered as only fair to poor forage. They have greater value as spring feed for wild game.

Western buttercup (*R. occidentalis*) is a typical perennial with erect, branched stems 12 to 28 inches tall. The hairy leaves grow mainly from the base of the plant and are about one to three inches long. Leaves are irregularly divided into three to five parts, each with pointed lobes. Flowers have five or six golden-yellow petals.

BALSAMROOT

Balsamorhiza sagittata

Commonly called arrowleaf balsamroot, this perennial has thick, tuberous roots under a tuft of silvery, arrow-shaped leaves about 6″ long. The large, yellow-petalled flowers are borne on a few, naked stems in early summer and are typical of the sunflower family.

Balsamroot grows most commonly on drier sites from 4,000 to 9,000 feet elevation in the Sierras, Cascade, and Rocky Mountain ranges. It is often associated with sage, pine, and fir types. The flowers and leaves are an important forage on spring ranges for all classes of stock and wildgame.

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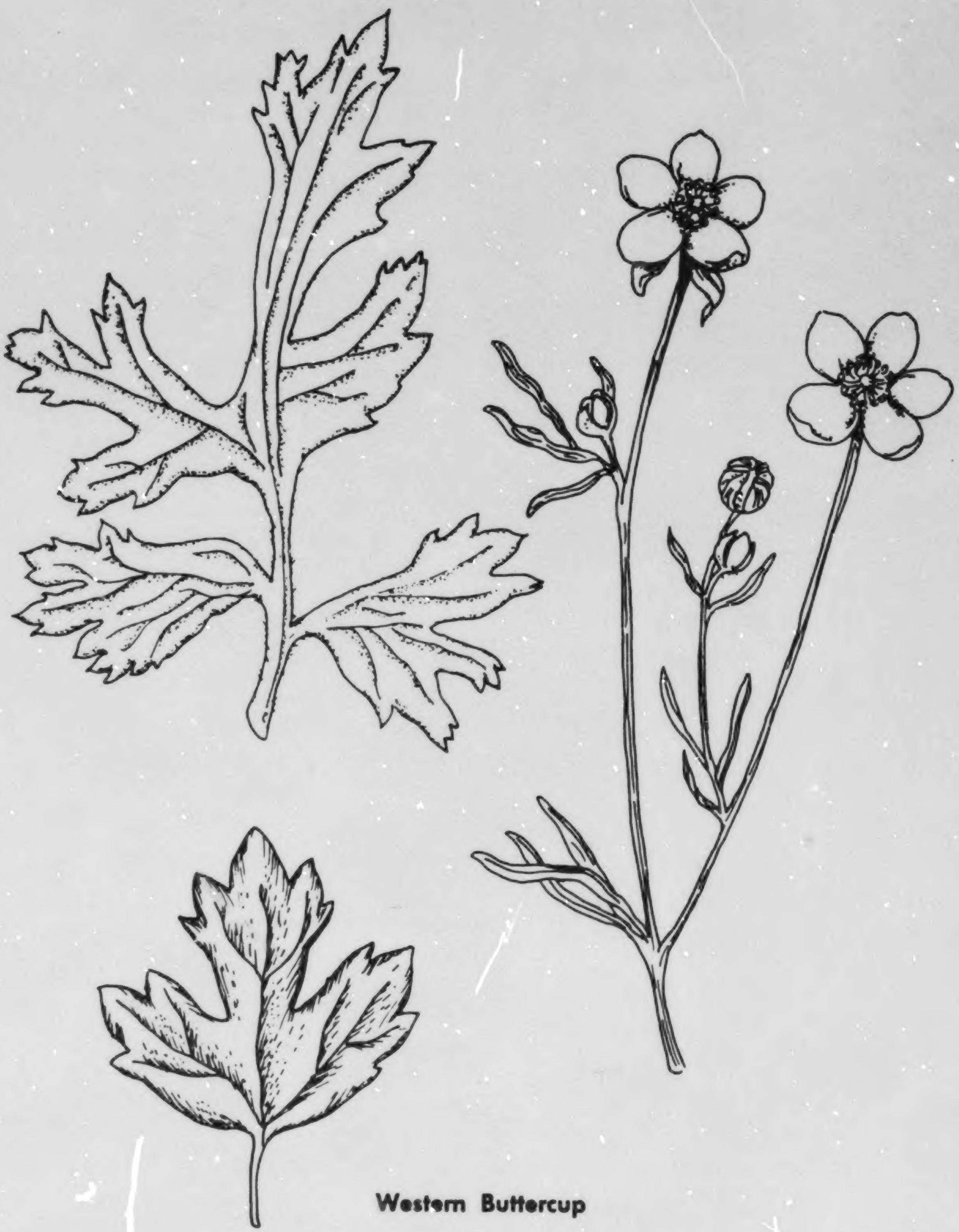


Western Buttercup

FILAREE

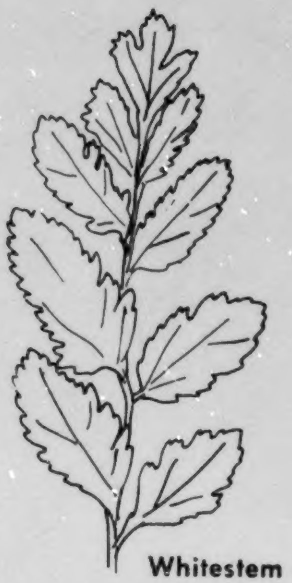
Erodium spp.

The filarees are introduced annuals of the geranium family. The leaves are finely divided into segments having toothed or lobed margins. They are on short stems forming a rosette on the ground following germination. Both stems and leaves are hairy. The flowers are rose or lavender in color and are borne in small clusters at the ends of stems. Each flower develops four seeds, each with an awn-like, long tail at maturity. The seed tails coil while drying and open when dampened, tending to "bore" the seed into the soil.

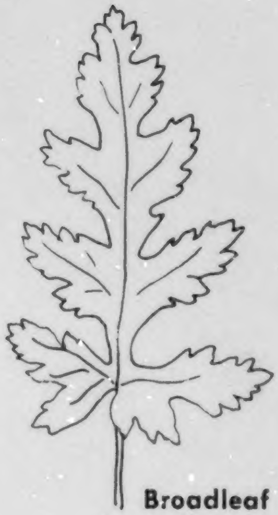
The filarees, *alfilerias*, are found throughout the West mostly below 6,000 feet and are especially common in Arizona and California. They are adapted to all soil types, particularly on dry ranges. The filarees are grazed by all kinds of livestock and game animals. They are especially utilized by sheep. Although they are short-lived, the forage is important as winter and spring feed, and is regarded as good to excellent in value. Filaree has superior ability to survive drought and heavy grazing.

Redstem filaree (*E. cicutarium*) is usually considered the best filaree since it is most palatable and nutritious. It is distinguished by short "beaks" or seed awns, and very finely divided leaves forming fern-like leaflets. The seed with awns are about one to two inches long. The leafy stems are commonly from three to twelve inches in length.

Broadleaf filaree *(E. botrys)* has longer (2-2½") beaks and simple, deeply lobed leaves. Whitestem filaree *(E. moshatum)* has short beaks and leaf character intermediate between the other filarees.



Whitestem Filaree



Broadleaf Filaree

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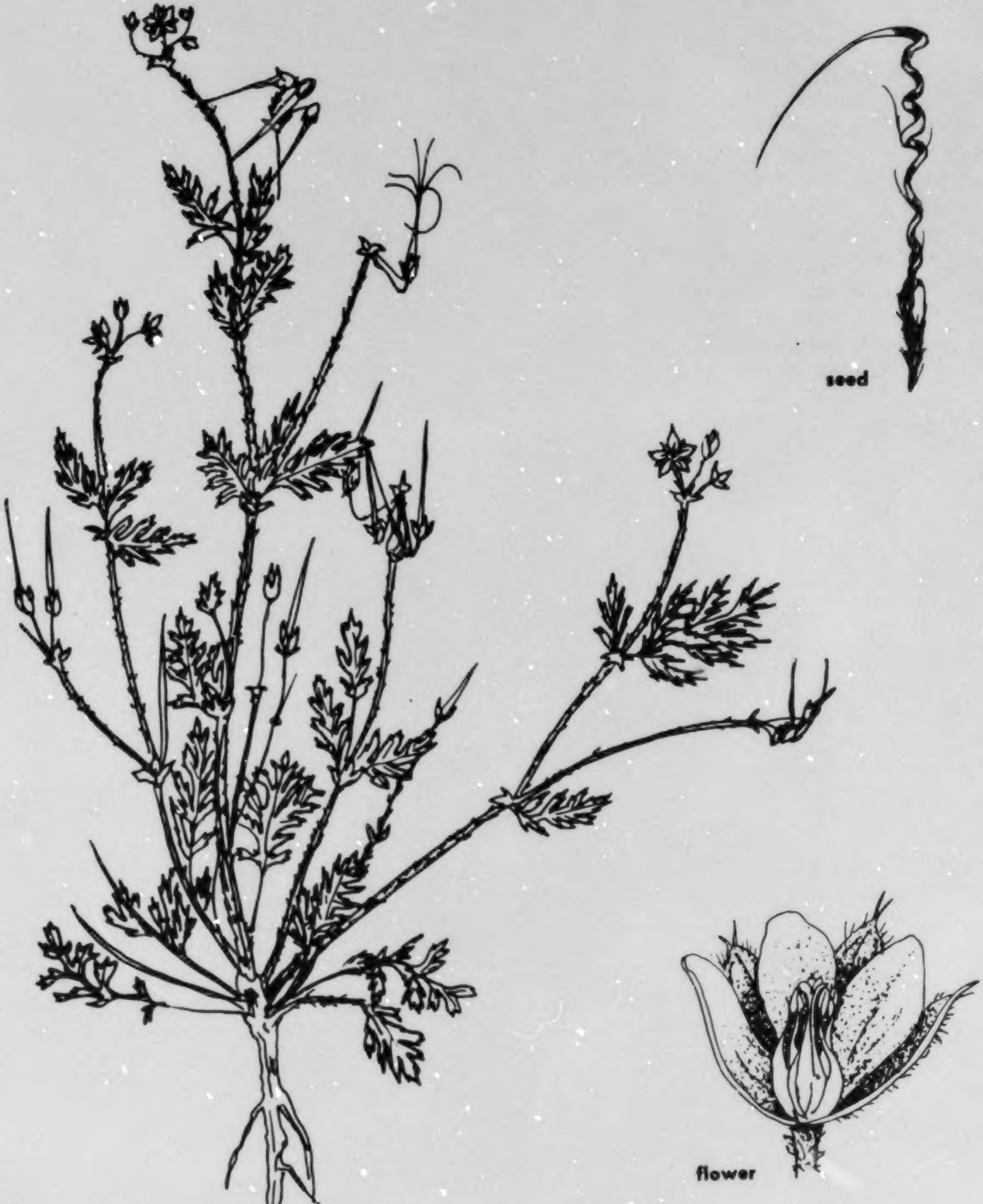

seed
flower

Redstem Filaree

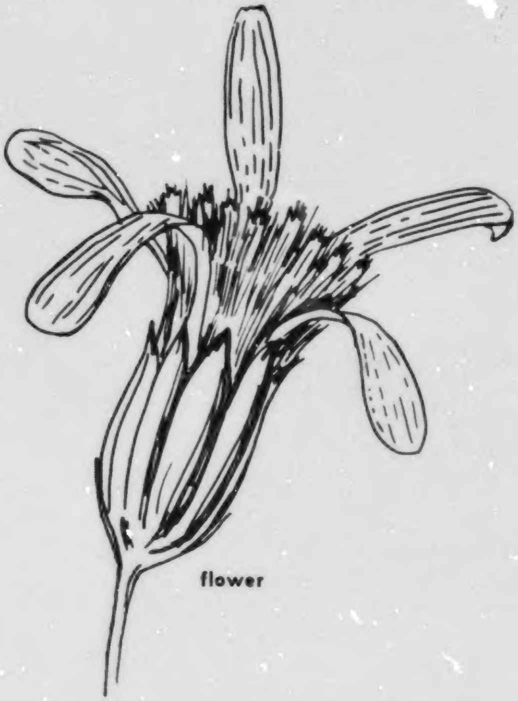
GROUNDSEL

Senecio spp.

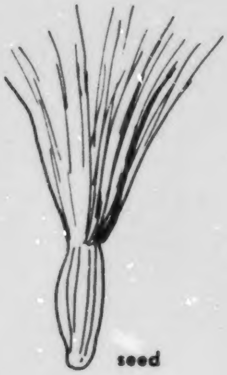
The groundsels are members of the sunflower family and are probably the largest group of flowering plants. They are recognized by erect, flat-topped groups of mostly small, composite flower heads. These usually have a few, slender, yellow ray petals and soft, white hairs from the disc flowers. Each head has two rows of bracts around it; one long, and another lower and shorter. Leaves are alternately arranged on the stems and usually simple. They are toothed on the margins but vary in shape.

The groundsels, or butterweeds, are found in all western states from sea level to 14,000 feet on wet and dry sites. Little is known of their forage value, but many rate from fair to good for sheep and cattle. Some species are known to cause poisoning of livestock. However, these are most abundant on depleted ranges and are grazed during scarcity of better forage.

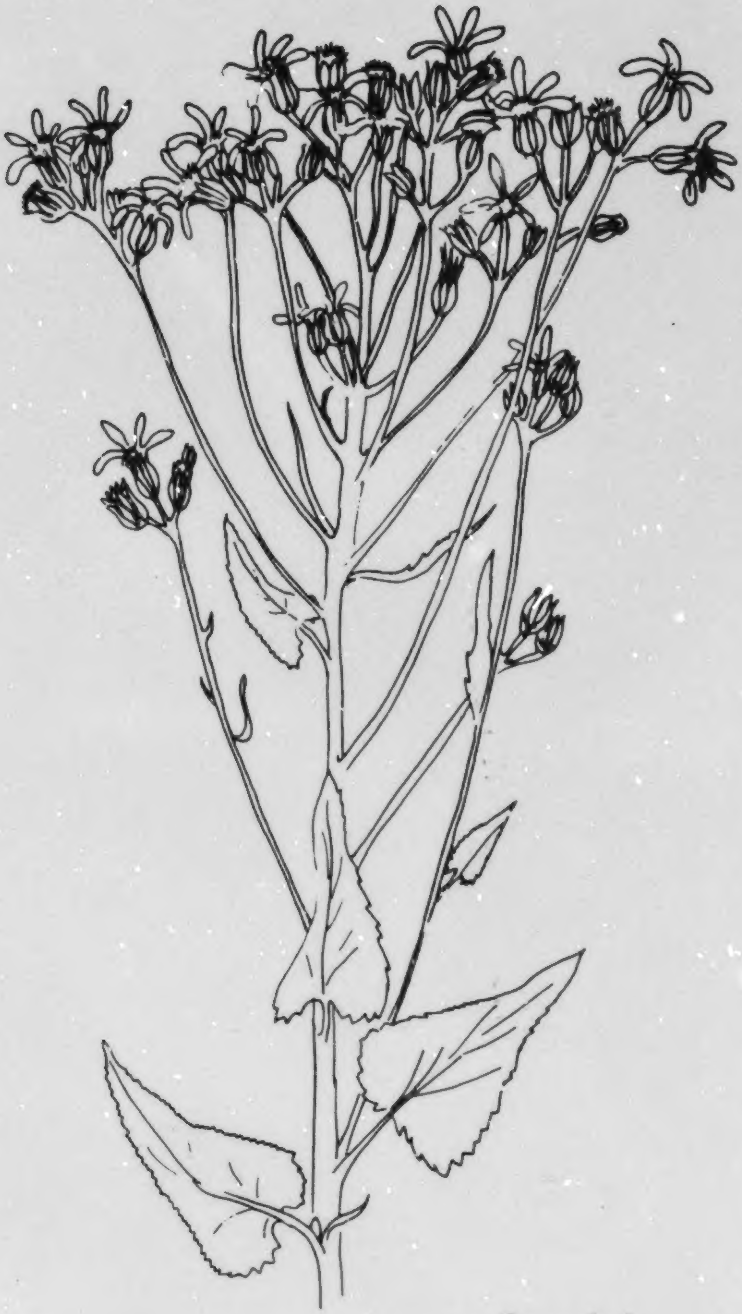
Arrowleaf groundsel (*S. triangularis*) is a tall, leafy perennial representing the forage types found in moist sites. Flowering heads are typical with five to twelve yellow petals (rays). The leaves are triangular or heart-shaped with irregular, toothed margins.



flower



seed



Groundsel

MULESEAR

Wyethia mollis

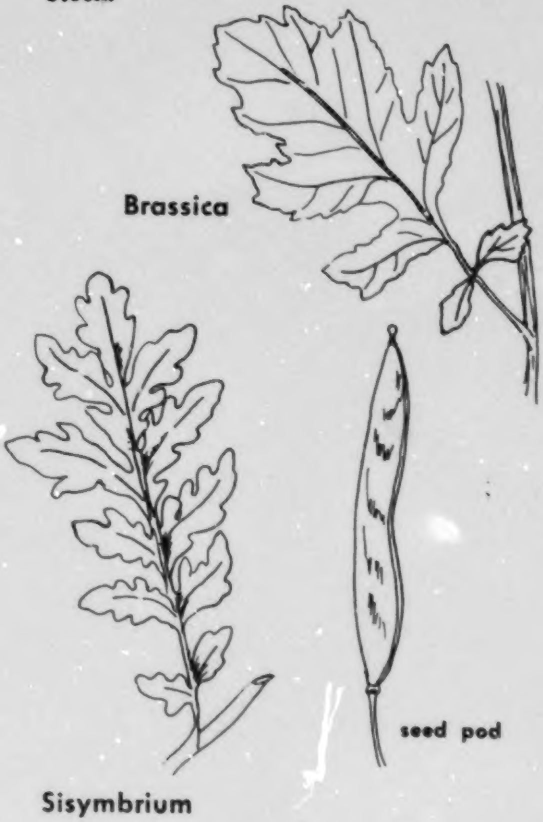
Wooly mulesear is a perennial herb with large, oblong leaves arising in a tight group from a thick root. These leaves are on long stalks reaching from 1 to 3 feet in height. Young leaves are white-wooly, the older more green and hairy, and from 7 to 19 inches in length. There are few flower heads on each plant and these are typical of the sunflower family with six to fourteen deep yellow petals about an inch long. These fertile "ray flowers" surround a yellow center of small, tightly arranged, fertile disk flowers. Mulesear is closely related and of similar value to balsamroot (*Balsamorhiza* spp.). These plants often occur together.

Wooly mulesear is confined to well-drained, dry, open ridges and flats in the pine and fir sites from 5,000 to 10,500 feet in the far-western states. New growth is fairly palatable in the early spring following snow melt, especially to sheep and deer. Although older leaves are not readily grazed, flower heads are eaten by cattle, sheep, and horses. The seed is high in nutrient value.

MUSTARD

Two mustards are common in the western states, common mustard (*Brassica* spp. and tansymustard (*Sisymbrium* spp.). Both are erect, branched annuals from 2 to 6 feet in height having alternate, toothed, lobed, or deeply dissected leaves. The 4-petalled flowers are in yellow clusters, later forming rounded pods of from ¼ to 2 inches long which contain many small, dark seeds. In common mustard, the pods are beaked, and longer (mostly over ½"), and the flowers are larger than in tansymustard.

The mustards are weedy, prolific plants typical of disturbed or overgrazed sites throughout the West up to 11,000 feet elevation. They are mostly unpalatable, the flowering parts only occasionally eaten by stock.



Mustard

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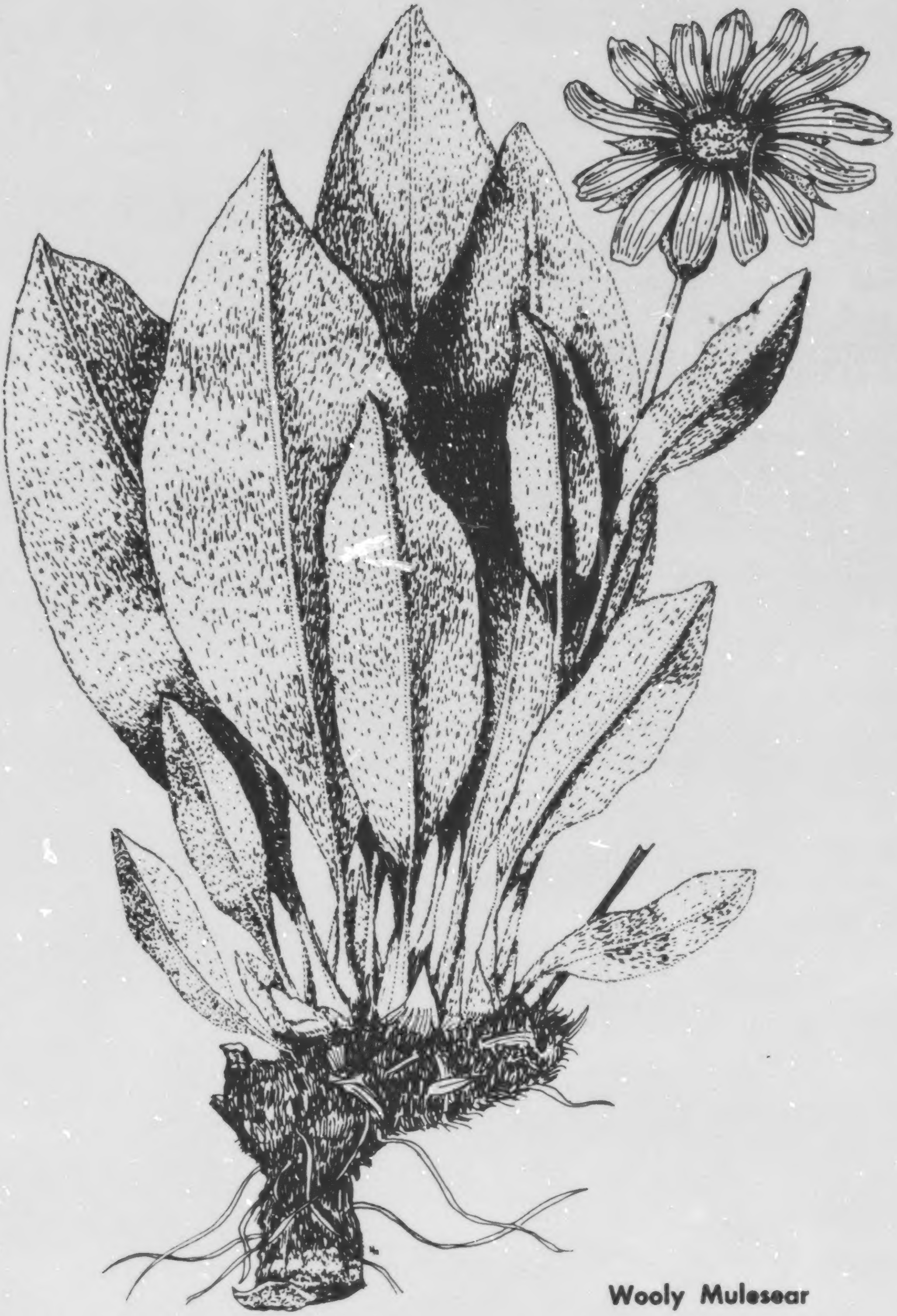
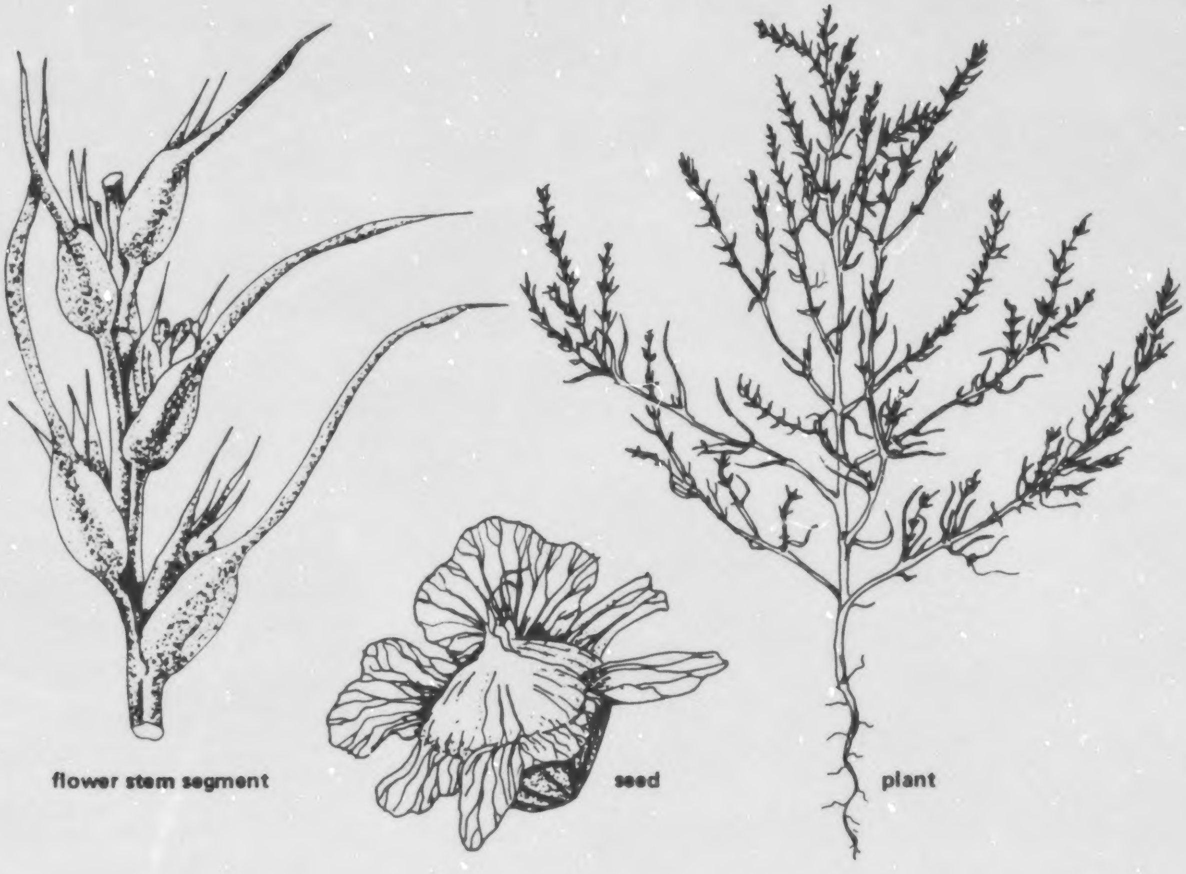


Wooly Mulesear

THISTLE

The name "thistle" includes many species of forbs having spiny or sharply barbed leaves and flowering bracts. Most thistles are closely related members of the sunflower family. They are stout biennials or perennials having large, bristly flowering heads composed of small tightly-combined flowers of yellow to reddish or purplish color. In this group are the many species of common thistles (*Cirsium* spp.) An exception is Russian thistle (*Salsola tenuifolia*), an introduced annual and a member of the goosefoot family. It has small, clasping bract-like leaves on branchy stems. Very small pink flowers are borne between the prickly leaf bracts which become even more spiny when dry.

The thistles are widely distributed in the West, generally below 9,000 feet on a variety of soils. Most are aggressive, noxious weeds common to disturbed lands, and around corrals, roads, and farms. The common thistles (including bull, Indian and Canada thistle) are mostly valley range species found primarily along field and



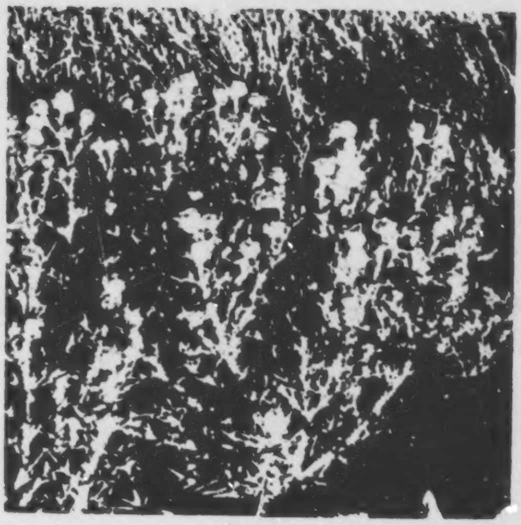
flower stem segment

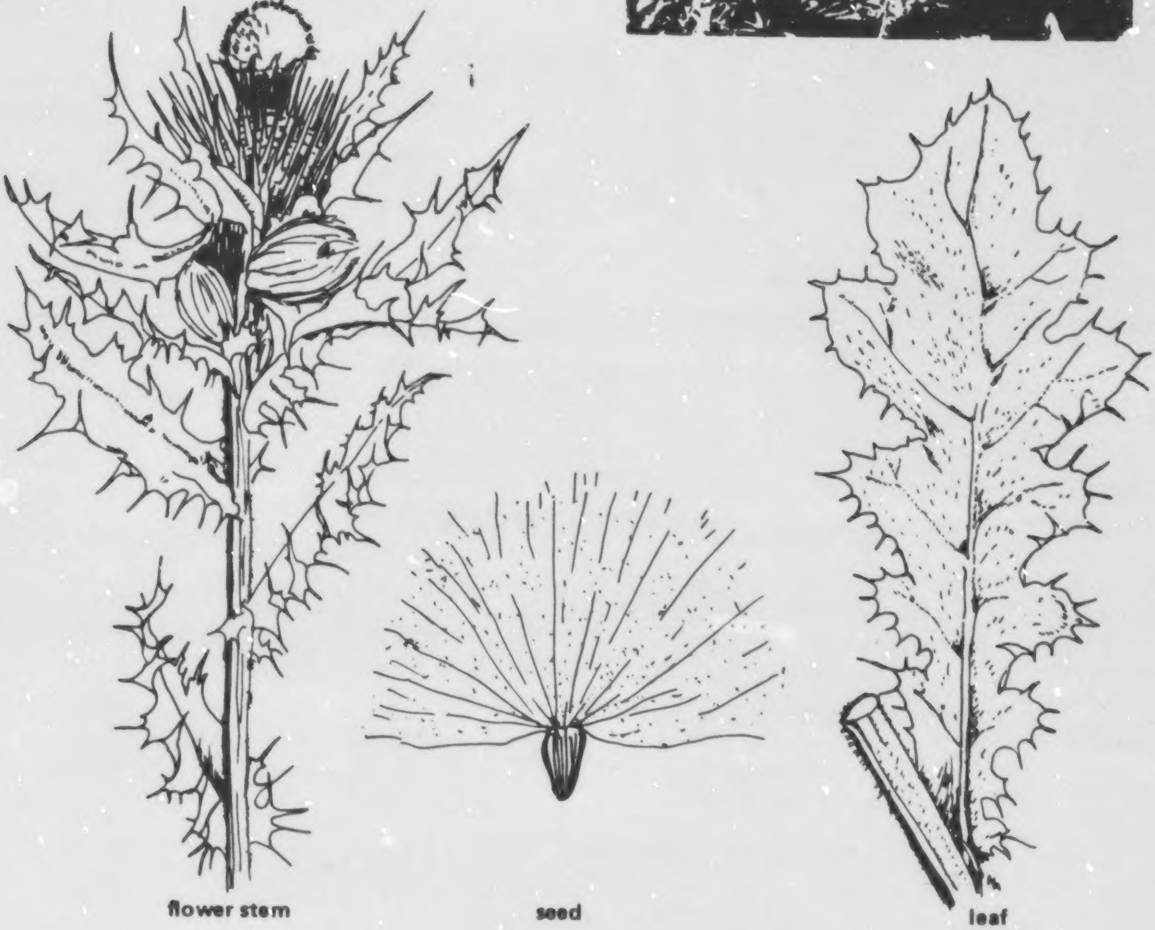
seed

plant

Russian Thistle

stream margins or in patches on deep soil. The foliage is little eaten by livestock and deer, but the seed heads are grazed by horses and cattle in the summer. Russian thistle is widely found up to 8,500 feet on dry flats and alkaline sites of the Intermountain West which have been cultivated or overgrazed. Seedlings are palatable and are valuable forage on many desert ranges and old croplands in the spring, but after maturity, the plants are unpalatable except when dampened by rainfall or dew.



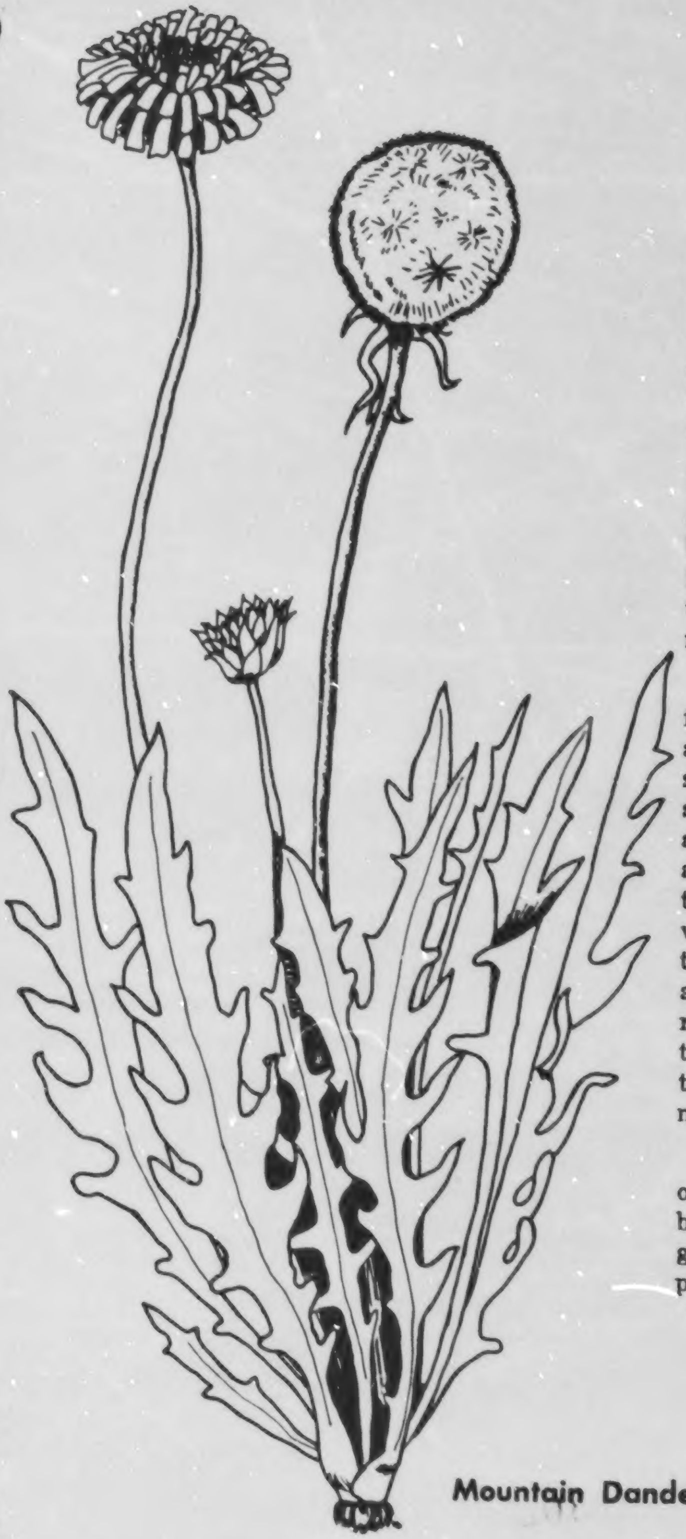


flower stem

seed

leaf

Indian Thistle



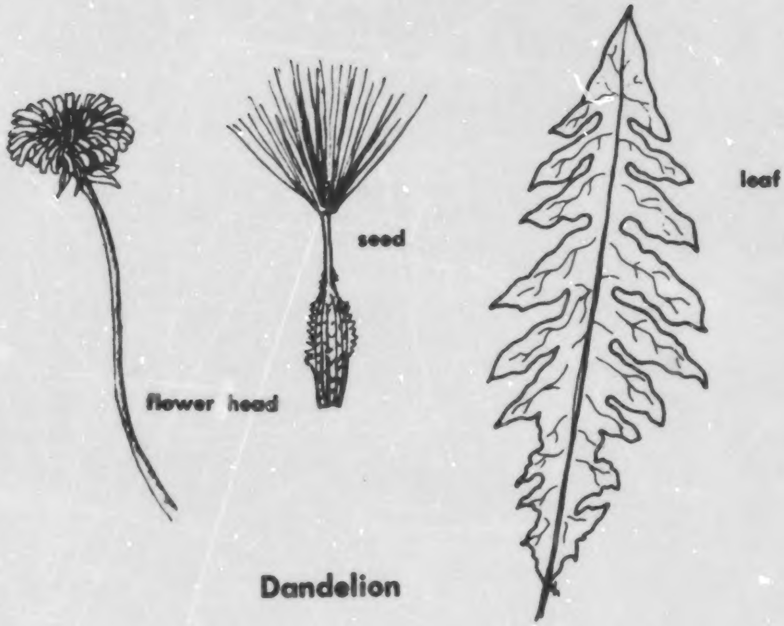
Mountain Dandelion

WILD DANDELION

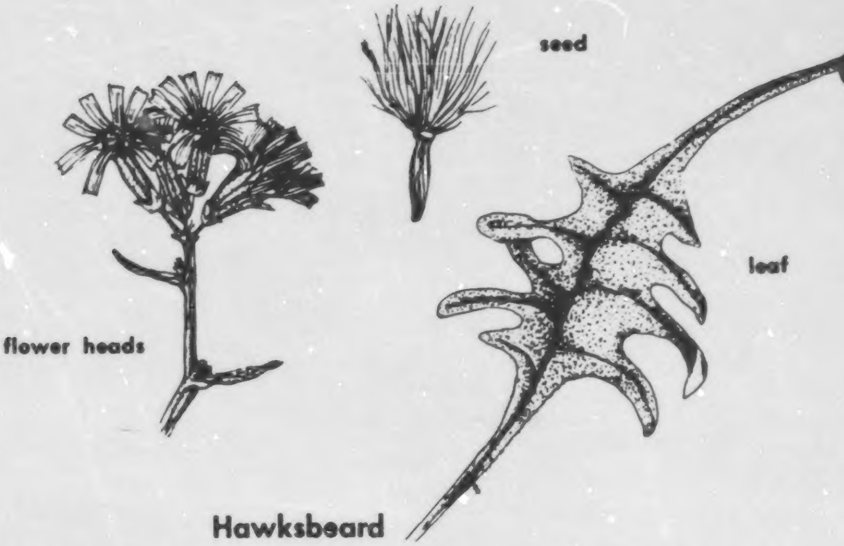
Wild dandelion is a general name for low-growing annual or perennial plants similar to the garden variety of dandelion. All belong to the sunflower family and have hairless leaves with smooth or indented margins which form a rosette on the soil. A composite head of yellow flowers grows erectly on one or more leafless stalks. The head matures into a crown of bristles or short, soft hairs protruding above the seed. Many species of dandelion (*Taraxacum spp.*) and mountain dandelion (*Agoseris* spp.) are included. They are very similar in value to the hawksbeards (*Crepis* spp.) which differ by having branched, leafy flowering stalks. All of these forbs have a taproot and produce a milky sap when the foliage is broken.

The dandelions occur on all range types from sea level to 11,000 feet. Some species are most common on heavier, more moist soils in mountain meadows and along streambanks; others occur in grasslands at lower elevations. The dandelions are abundant on overgrazed cattle range or disturbed eroded sites, but they also occur on well-managed ranges. As with the domestic variety, wild dandelions are adaptable, aggressive, and persistent. Their deep taproot and abundant seed production enables them to withstand stress. Growth is continuous from early spring through summer when moisture is available.

The dandelions and hawksbeards are only lightly grazed by cattle and horses, but are eagerly eaten by sheep. They are generally considered only fair as forage plants.


seed
leaf
flower head

Dandelion


seed
leaf
flower heads

Hawksbeard

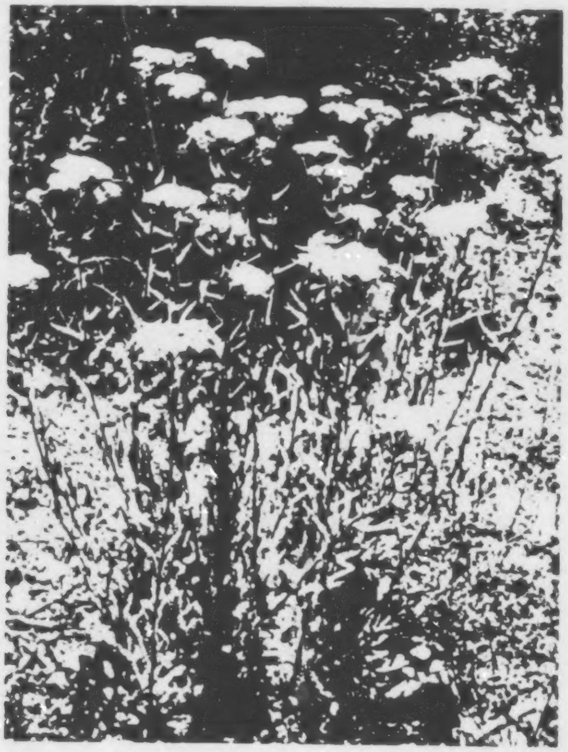
YARROW

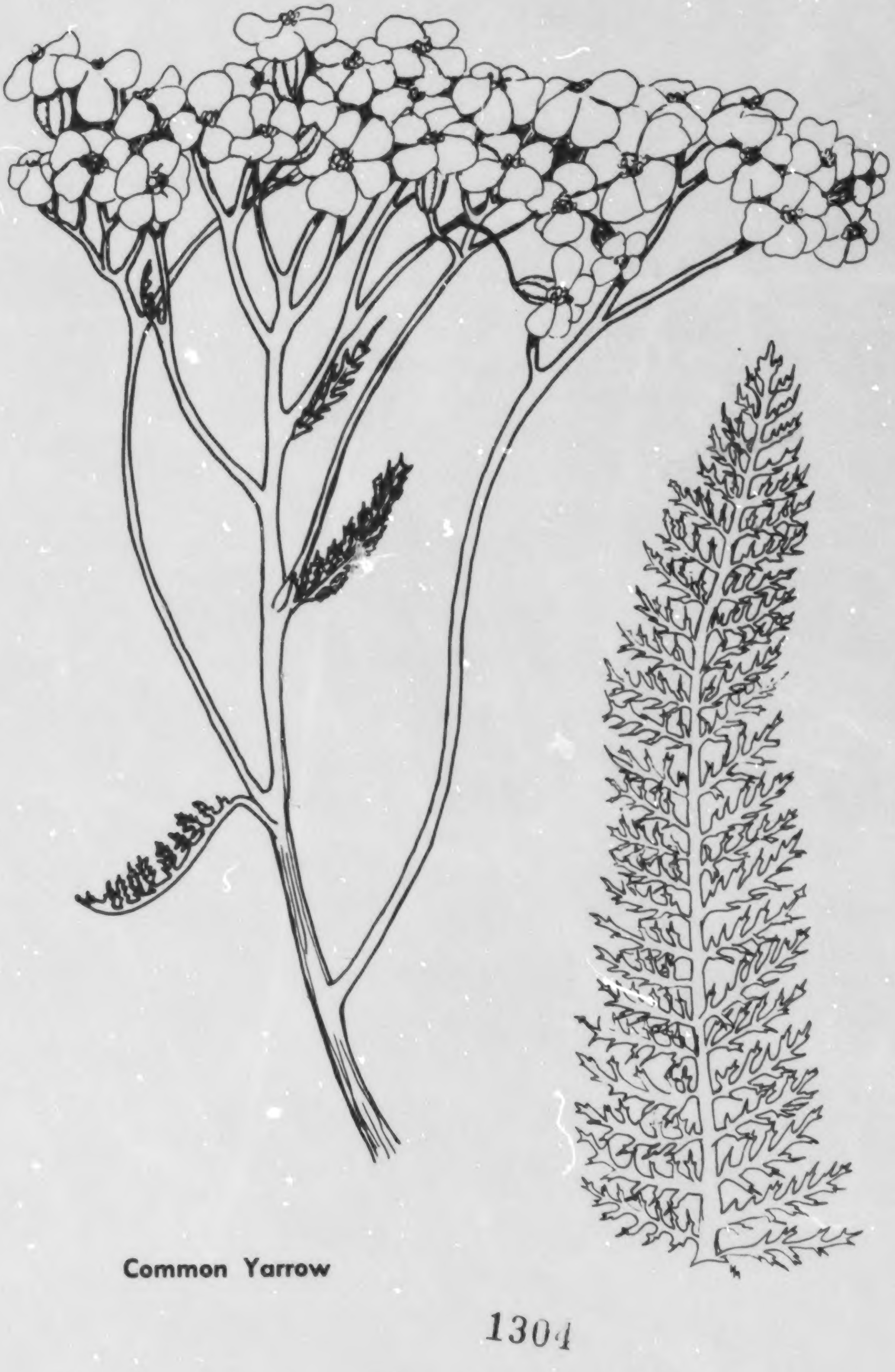
Achillea spp.

Common (western) yarrow is a perennial herb of the sunflower family, growing from 12 to 36 inches tall with a simple, erect stem and underground rootstalks. The fern-like leaves, more numerous at the base, are more or less lance-shaped and have finely divided and deeply-lobed segments crowded on the stalk. The leaves and stem are usually covered with long, soft hairs. The numerous flower heads are borne in flat-topped or convex clusters. The five or six ray flowers are white and surround 25 to 30 yellow disk flowers.

The two common species of yarrow in the West are difficult to tell apart, because they vary in appearance. The yarrows are widely distributed from sea level to 8,000 feet elevation in a great variety of habitats, but are most commonly scattered on grass or shrub-grass sites, particularly where ranges have been heavily grazed.

The value of yarrow as forage varies among areas but is generally regarded as poor to worthless. Yarrow sends up new growth each year from the perennial root stalks and remains green and produces flowers throughout the summer. Sheep may graze the plants moderately during the season and cattle will sometimes eat the flowers. Deer and other wildlife make little use of yarrow. The plant contains bitter, slightly toxic substances.





Common Yarrow

Appendix E

DESCRIPTIONS OF IMPORTANT POISONOUS RANGE PLANTS

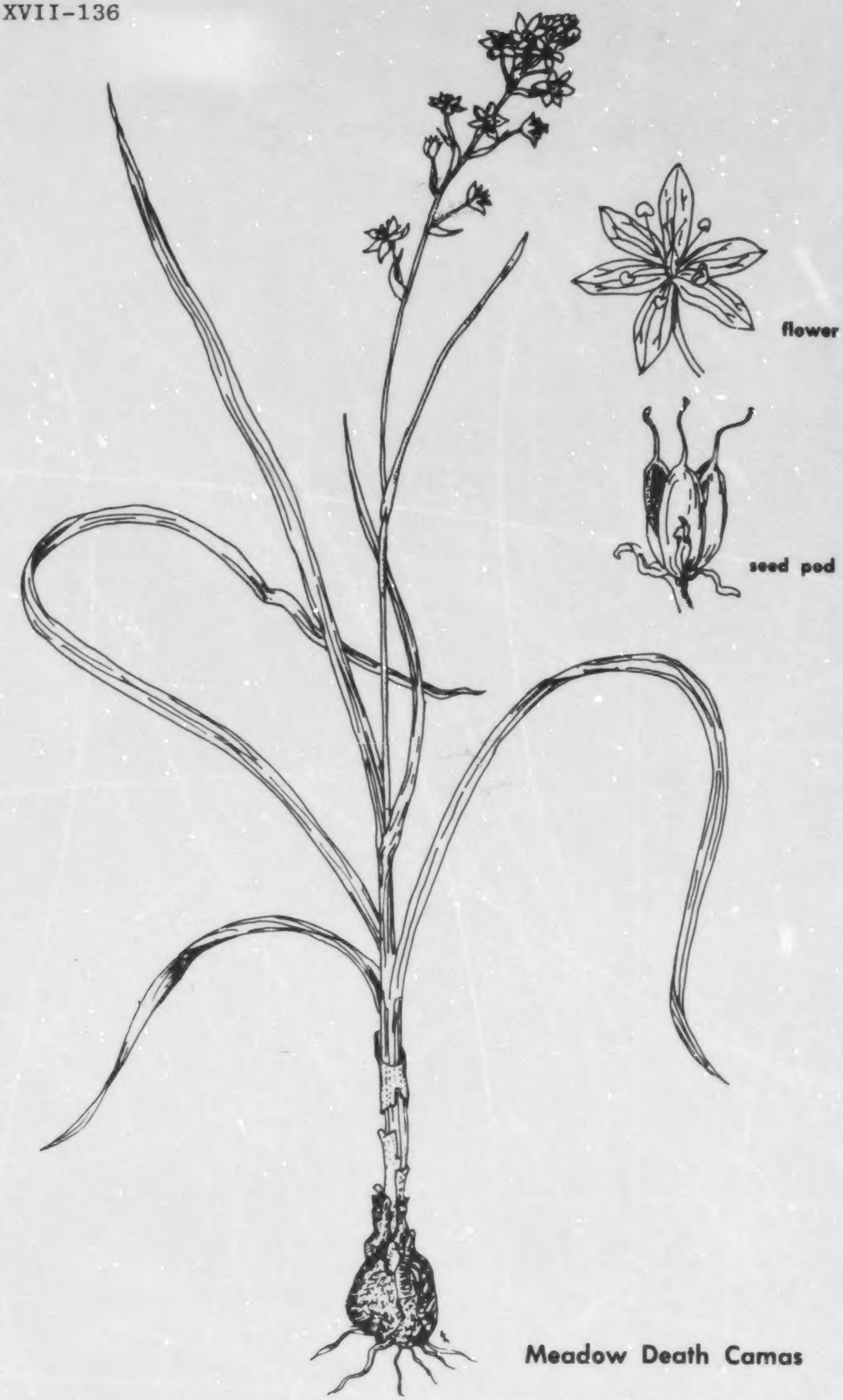
DEATH CAMAS

Zygadenus spp.

Death camases are perennial herbs belonging to the lily family which develop from onion-like (but odorless) bulbs. The leaves are narrow and grass-like. The erect leaves and stems are 6 to 40 inches tall, depending upon the species and the site. The flowers are white, have six petals, and are either borne along the flower stem or on short branches. The wrinkled seeds are black and borne in capsules ½ to 1 inch long.

Several species of death camas occur in western foothills and mountains from sea level to about 8,000 feet in elevation. Different species are found according to the nature of the site. Meadow death camas (*Z. venenosus*) is common on more moist grassland types; foothill camas (*Z. paniculatus*) is found on dry, exposed areas often associated with chaparral types. Meadow death camas is considered the most poisonous of all the species.

The plants contain several alkaloids that directly affect grazing animals by disturbing heart action, respiration, and general muscular control. Sheep are most affected and may die if one-half to two pounds of death camas is eaten. However, the degree of toxicity may depend upon the plant species. In most cases, the danger of death camas poisoning is greatest in the spring when new leaf growth is rapid and from the bulb. Young leaves and bulbs are most toxic.


flower
seed pod

Meadow Death Camas

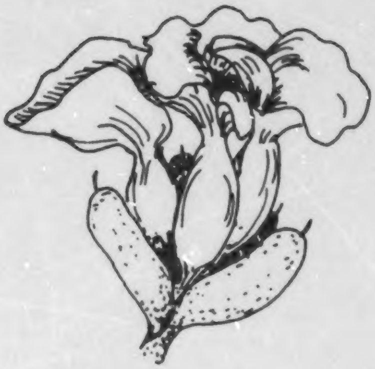
HALOGETON

Halogeton glomeratus

Halogeton is an annual plant of the goosefoot family, which branches from the base. The stems are 5 to 15 inches high. The leaves are somewhat "sausage-shaped," ¼ to ½ inch long, succulent, grey to blue-green, the blunt tip provided with a small bristle. The flowers are inconspicuous in the axils of the leaves but the developing fruits have broad, papery wings for easy scattering by the wind. The seeds have high viability.

Halogeton plants are developed best on arid, alkaline soils where competition from other plants is at a minimum. Roadsides, railroad beds, corrals, and bedding grounds are initial sites where the plant may spread into overgrazed rangelands or burned-over areas. Halogeton is most dangerous along sheep trails where it may grow in abundance and be readily available and palatable to hungry animals. Plants affected by dew or frost are especially dangerous.

The plant is poisonous to sheep because of soluble oxalates accumulated in the sap and tissues. Oxalate crystals block the tubules of sheep kidneys and cause excretory disturbances. Oxalates also remove large amounts of calcium from the bloodstream causing nutritional imbalance. Due to the high concentrations of these chemicals in Halogeton, 12 to 18 ounces of the plant is lethal. General weakness occurs about four hours after feeding and progresses into drooling, frothing, nasal discharge, shallow breathing, and finally coma.



Flower Segment

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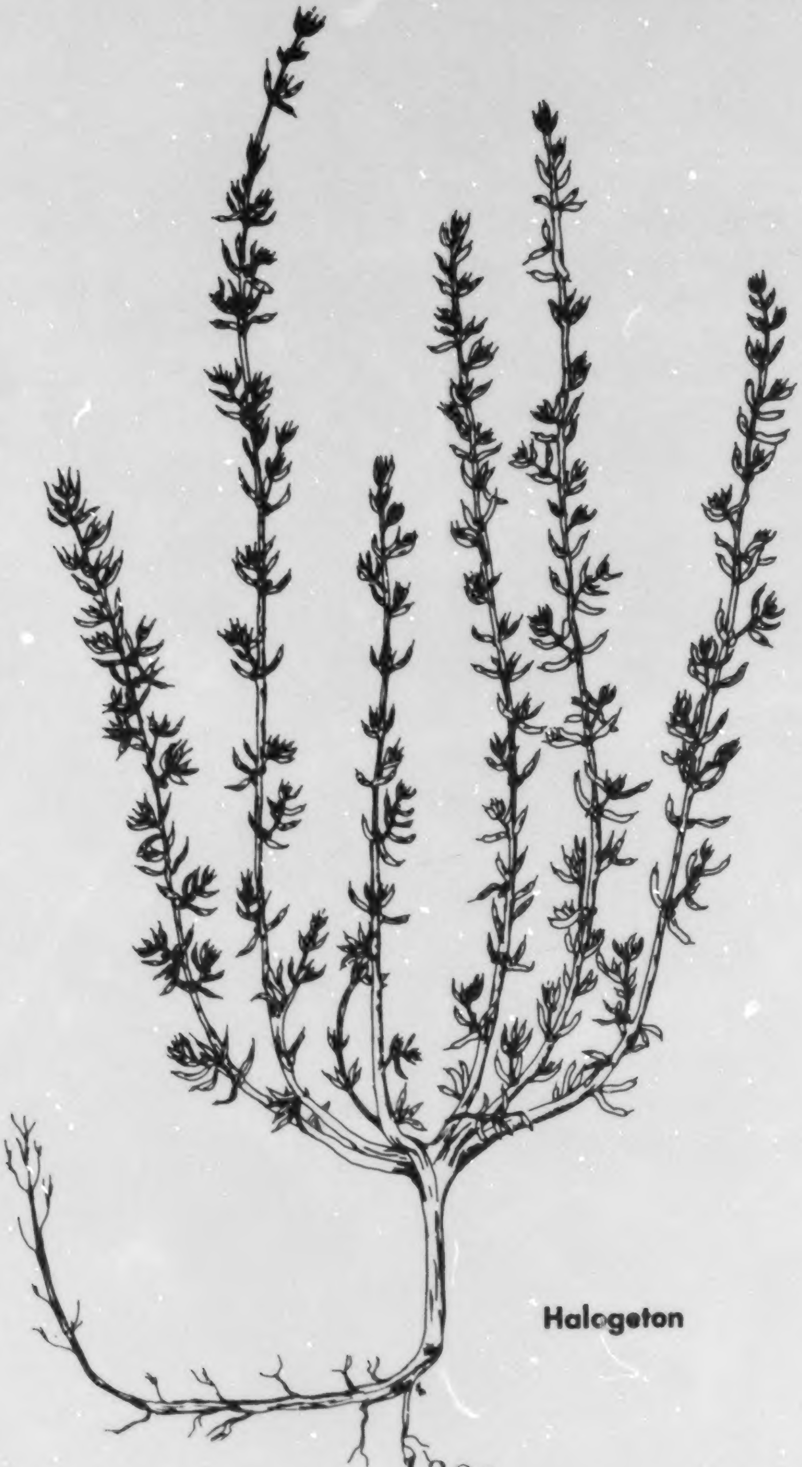


Halogeton

1308

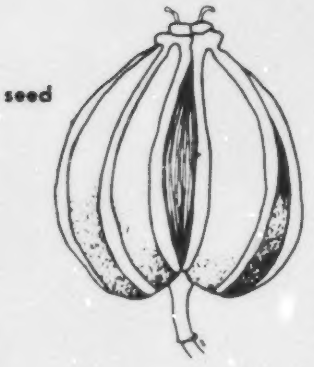
HEMLOCK

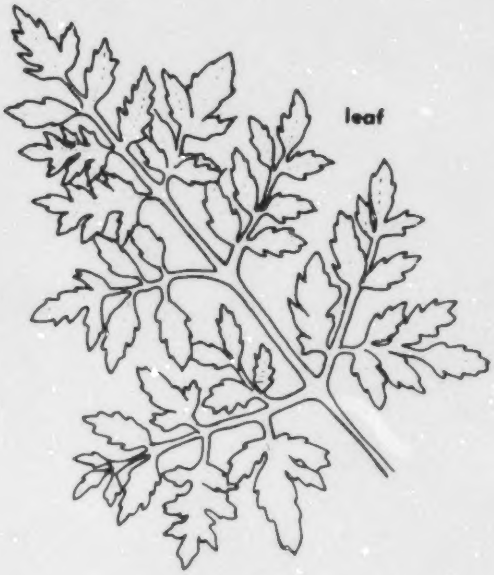
The hemlocks are members of the carrot (parsley) family. Two closely related hemlocks are of importance in range management. Western water hemlock (*Cicuta douglasii*) is one of the most poisonous plants found on rangeland, particularly to cattle. Poison hemlock (*Conium maculatum*), although somewhat less commonly eaten, is nevertheless highly toxic. Both hemlocks are found below 5,000 feet in moist, shady, stream banks, although poison hemlock often inhabits deep soils on drier sites.

Western water hemlock is a perennial plant with stout, smooth stems 1½ to 4 feet tall. The compound leaves have one to three major divisions, each division with leaflets arranged on each side of a common stem. The leaflets are lance-shaped, 1¼ to 4 inches long with toothed margins. The numerous, white, five-petaled flowers are on short stalks grouped in small unbrella-shaped clusters. A yellow oil is visible when a root of western water hemlock is cut, but the resin contains the principal poison.

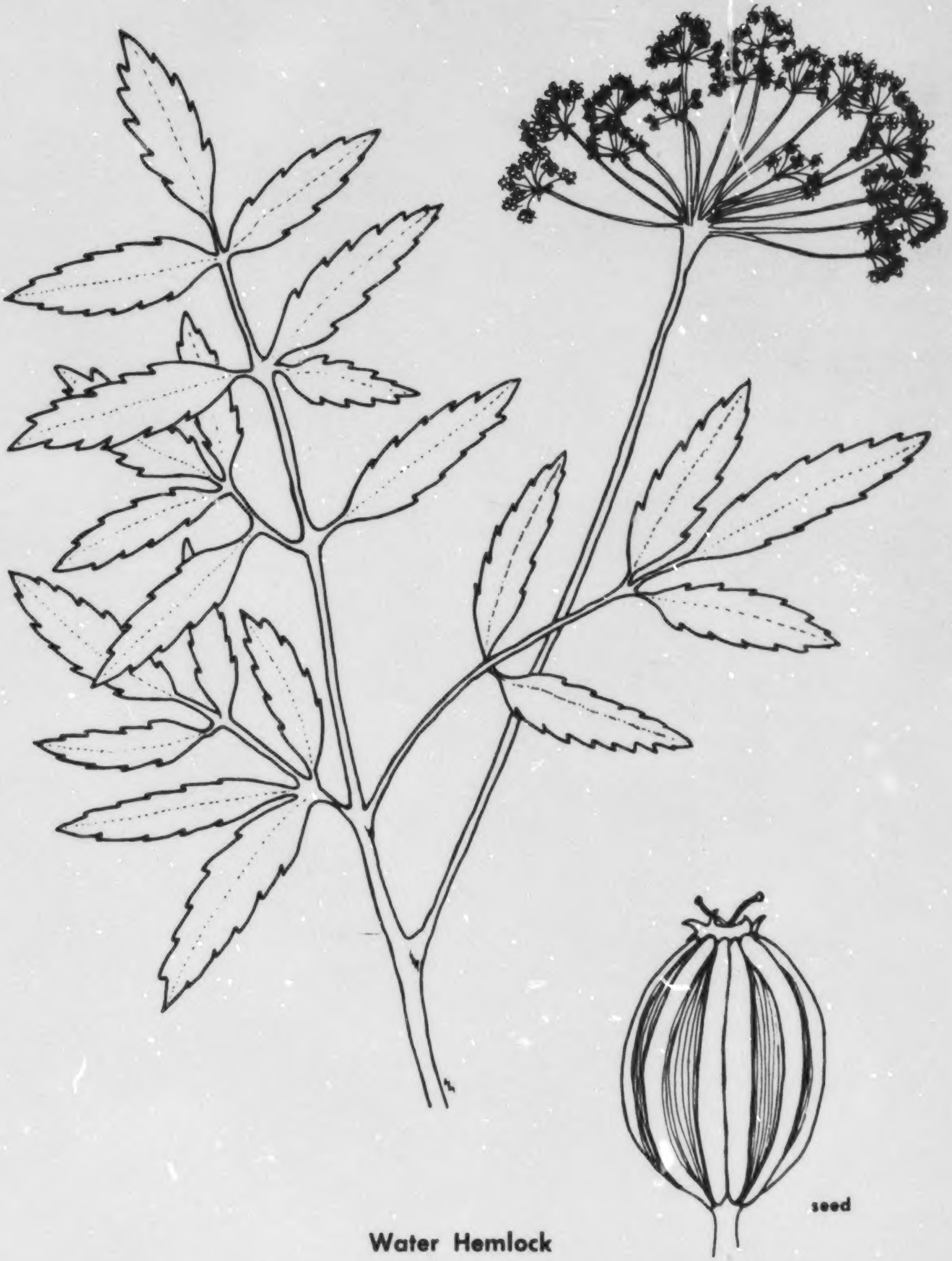
The poisons are found mostly in the roots. Grazing animals can easily pull up and eat the roots because the plants grow in wet, soft ground. The stems and leaves are most poisonous when young. The poison of the foliage declines later in the season, and dry foliage presents little hazard. However, dried roots are extremely toxic, and ½ ounce is enough to kill a mature ewe. Symptoms of poisoning in livestock include: muscle twitching, rapid pulse, rapid breathing, tremors, violent convulsions, dilation of the pupils, excessive drooling, frothing at the mouth, and coma. Symptoms usually appear one to six hours after eating.

Poison hemlock is a branching biennial herb with smooth, hollow stems from 2 to 10 feet tall. The stem is usually spotted with purple that helps to identify it. The leaves are 1 to 2 feet long. The compound leaflets are divided into many fine segments, more so than the other hemlock. Lower leaves have a stem but the upper leaves do not. There is a disagreeable odor to the leaves. Seeds are oval, slightly flattened, and have large ribs. All parts of the plant are toxic, but the seeds are most dangerous.





Poison Hemlock



Water Hemlock

LARKSPUR

Delphinium spp.

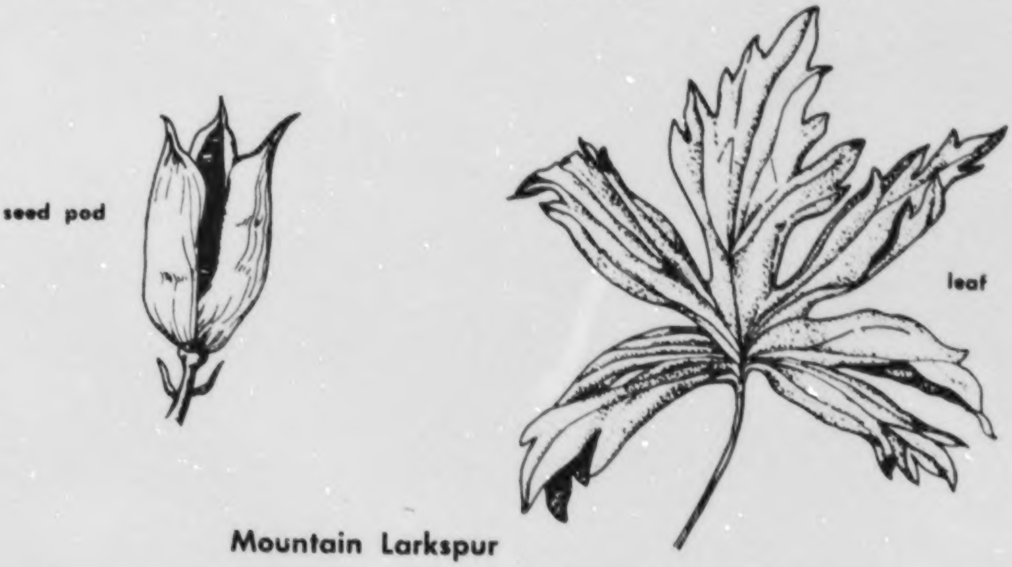
Larkspurs are erect, branching, perennial herbs of the buttercup family. The stems, a few inches to 7 feet tall, arise from a woody base with fibrous or fleshy roots. The leaves are rounded in outline and deeply lobed or divided, similar to a maple leaf. The flowers, which are usually deep blue, are irregular in shape. They have a distinct cone-shaped spur and are borne in groups on a long spike.

There are many species of larkspur in the West, occuring from sea level to elevations of 11,000 feet on a variety of sites.

Larkspurs are usually divided into tall larkspurs and low larkspurs when discussing their poisonous properties. The tall larkspurs usually have many stems 3 to 7 feet tall, and are most often found in moist habitats. Mountain larkspur (*D. glaucum*) is an example.

Low larkspurs are usually less than 3 feet tall, have solitary or few stems, and are found on dry as well as moist sites. Menzies larkspur (*D. menziesii*) represents this group. Low larkspurs are more abundant than the tall ones. The low larkspurs flower early in the season and their tops soon die and disappear. The tall larkspurs tend to mature later and the tops often last until fall. Also, low larkspurs are poisonous throughout the life of the plant while the foliage of tall larkspurs loses its poison after blossoming. Larkspur seeds are very poisonous but are seldom eaten by livestock. It is likely that all species of larkspur are toxic. The alkaloids act on the nervous system causing staggering, falling, nausea, excessive drooling, frequent swallowing, quivering of muscles, slowing of heart action, and paralysis of breathing.

Horses rarely eat the plant and sheep seldom are poisoned although they frequently graze the plant. Cattle, although easily poisoned, will feed on larkspur even when good forage is available. However, most livestock losses occur in early spring, because the larkspurs begin growth very early and are available when other forage is scarce.



Mountain Larkspur

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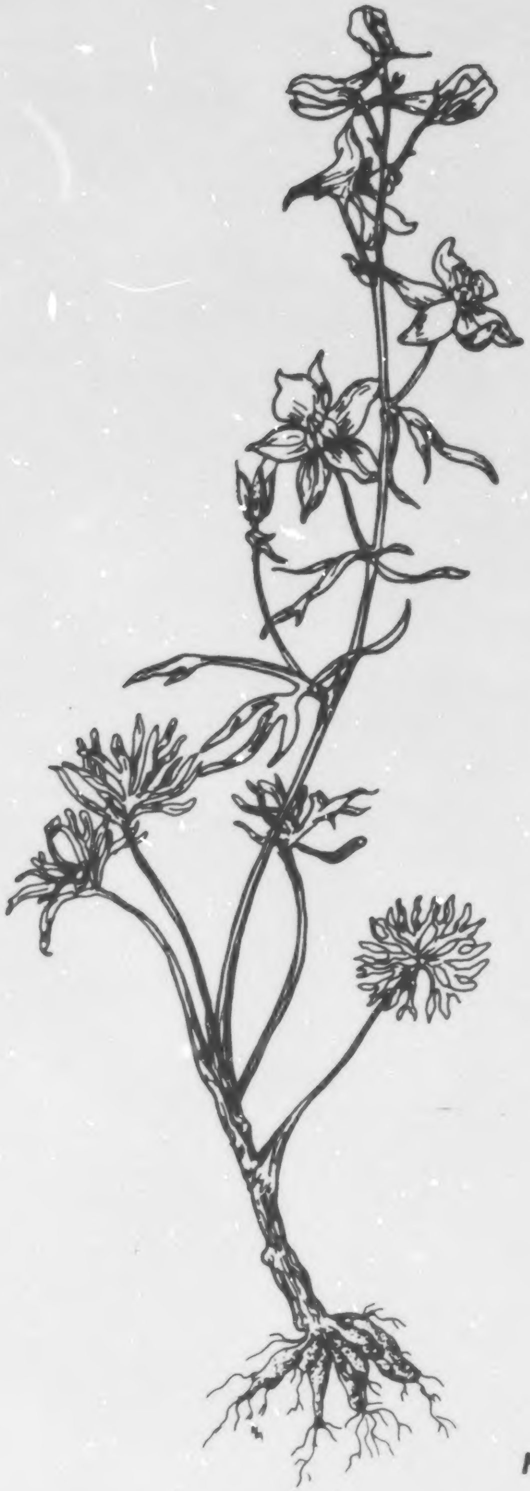
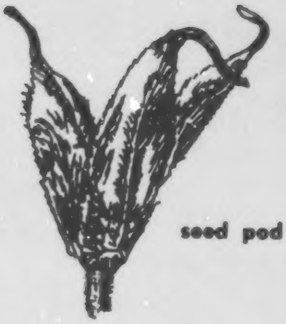
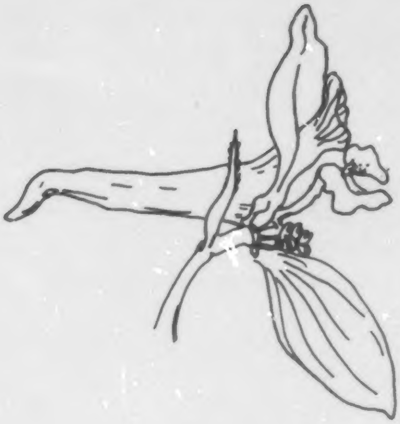






Menzies Larkspur

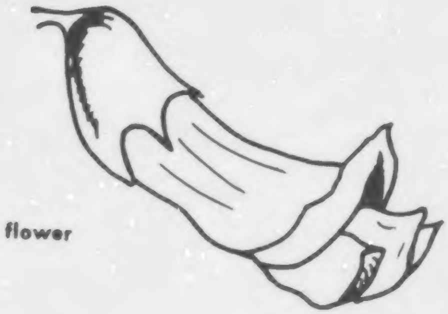
LOCOWEED

Astragalus spp.

The locoweeds are perennials which belong to the legume family. The stems vary from low-growing to erect, or, the only visible portion of the plant may be a cluster of short leaves and a flowering head. Leaves are divided into many pairs of smooth-sided leaflets with an odd leaflet at the end of the leaf. The flowers are purple, yellow, or white and appear in small clusters arranged along the tip of a long stem. A characteristic feature of locoweeds is the large bladder-like pod produced by most of the species. The small seeds contained inside are kidney-shaped.

It is difficult to distinguish between the species of locoweed, and all species should be considered dangerous to all livestock. The locoweeds are most common on dry ranges where they inhabit rocky, exposed soils.

The poison in the locoweeds is an alkaloid which is both cumulative and habit-forming. In some areas, selenium is easily absorbed by the locoweeds. Either or both can be present in toxic amounts in all stages of plant growth. The locos are not very palatable and large amounts must be consumed by a grazing animal before symptoms appear. These include general weakness, erratic sense of direction and gait, nervousness, lack of muscular control, and occasional violent reactions. Cattle, sheep, goats, and horses may develop a preference for locoweed and prefer it to other plants. This is especially true on desert ranges where palatable forage is at a minimum and locoweed is common.



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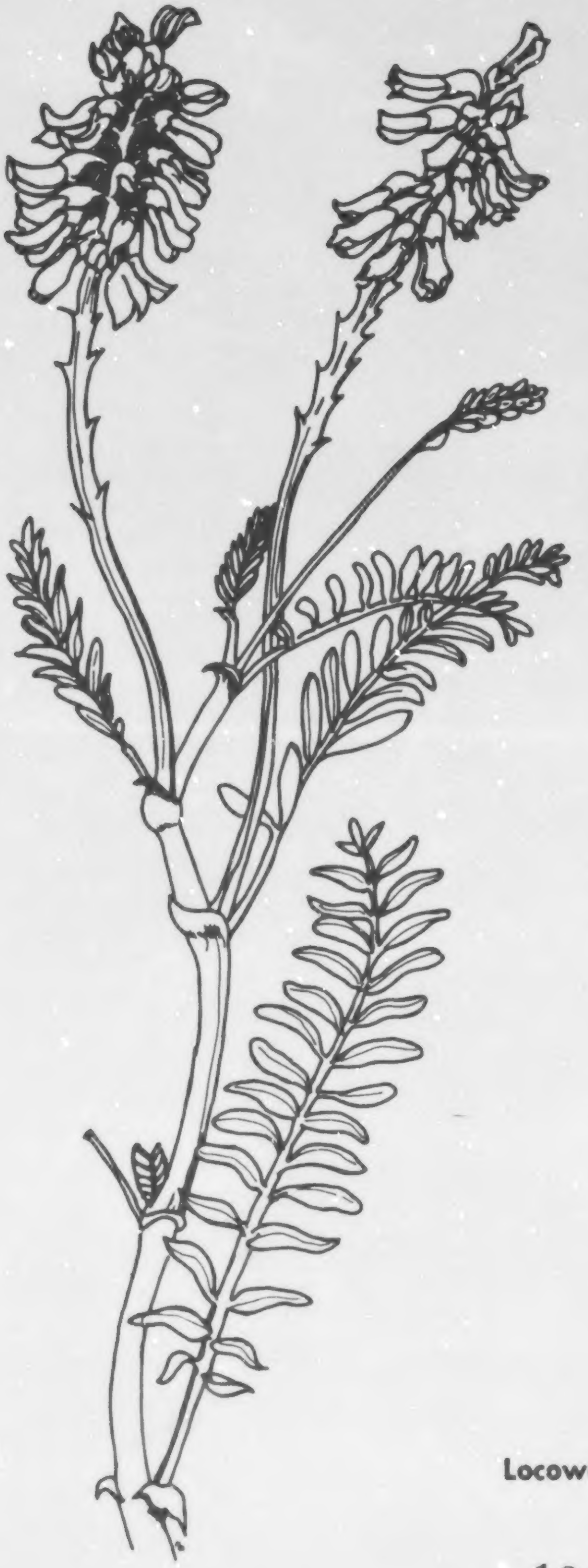
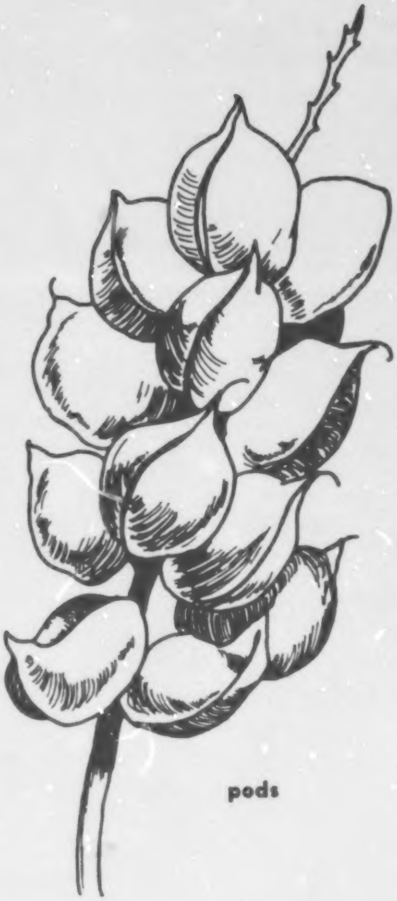




pods

Locoweed

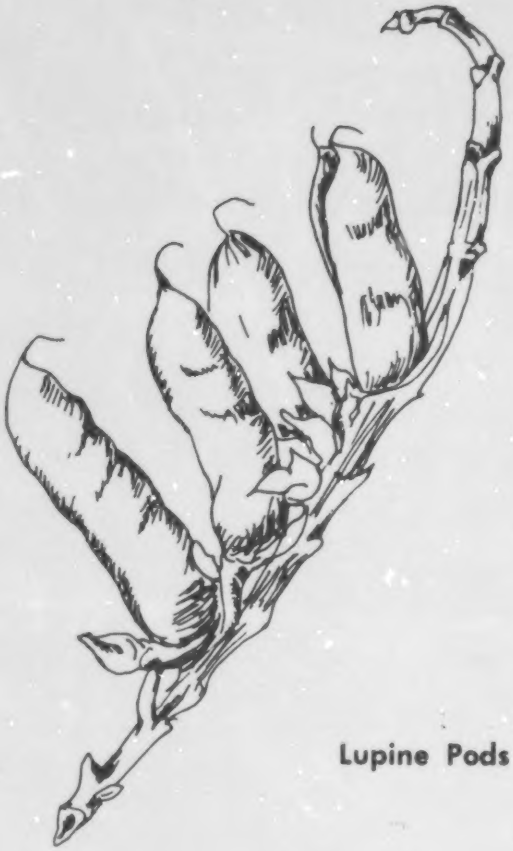
LUPINE

Lupinus spp.

The lupines are annual and perennial herbs, or shrubs belonging to the legume family. They range in height from a few inches to almost 6 feet. The leaves are most distinctive, consisting of four or more leaflets arranged like fingers on the tip of the leaf stalk. The flowers are typical of the pea family, usually large, commonly blue or purple, and arranged in short or long, dense groups. The pods are bean-like, usually hairy, and are constricted between the seeds. When mature, they readily split apart to release the seeds.

Many lupine species occur in the West. Some annual species are prominent spring wild flowers in valleys and foothills. Many (but not all) of the perennials are either suspected or known to be poisonous. The annuals are not. Most lupines are summer-flowering perennials found on dry, open slopes or flats of the pine and sagebrush sites from 2,000 to 7,000 feet.

The lupines are poisonous to livestock when green or dry. All parts of the plant are harmful, but the seeds are especially toxic. Although the amount needed to kill cattle is not known, as little as ½ pound is lethal to a sheep. Symptoms of poisoning include frenzied action, butting, frothing at the mouth, difficulty in breathing, uncoordinated movement and falling. Sheep, frequently the victims of lupine poisoning, are apparently less affected by some lupine than are cattle. Cattle normally show little interest in lupines until the seed pods are well-formed during late summer. At this time seed pods and plant tops may be extensively eaten. The numerous alkaloids responsible for lupine poisoning do not accumulate in the body, and animals can eat comparatively large quantities if the toxic limit is not reached at one time.



Lupine Pods

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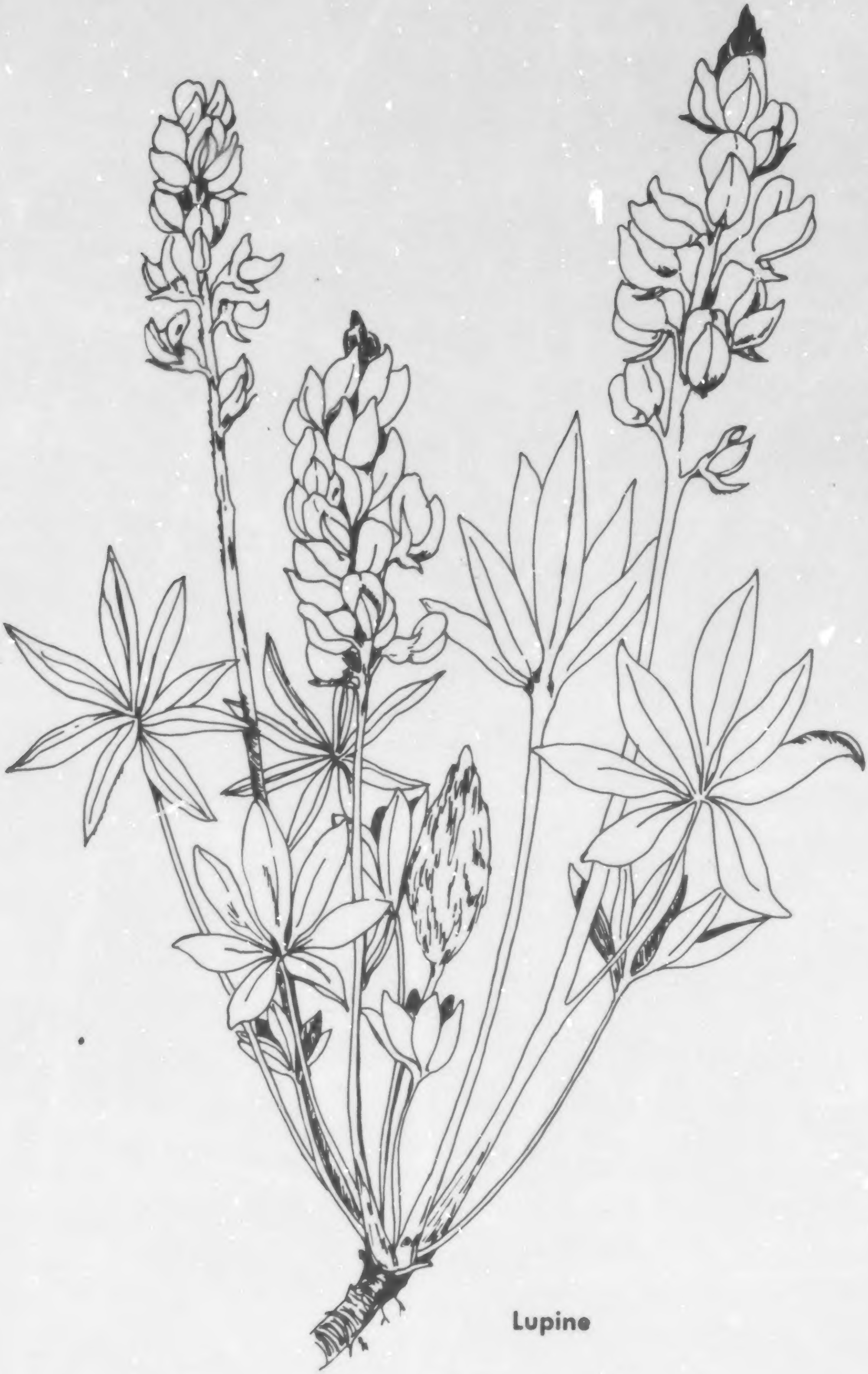


Lupine

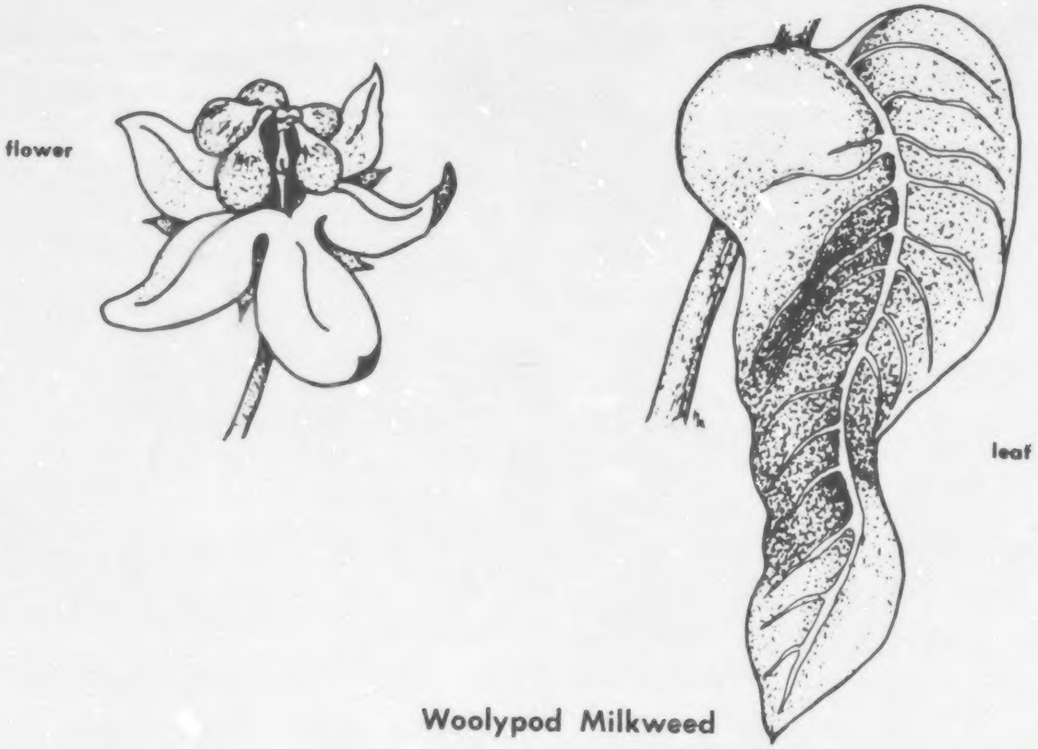
MILK WEED

Asclepias spp.

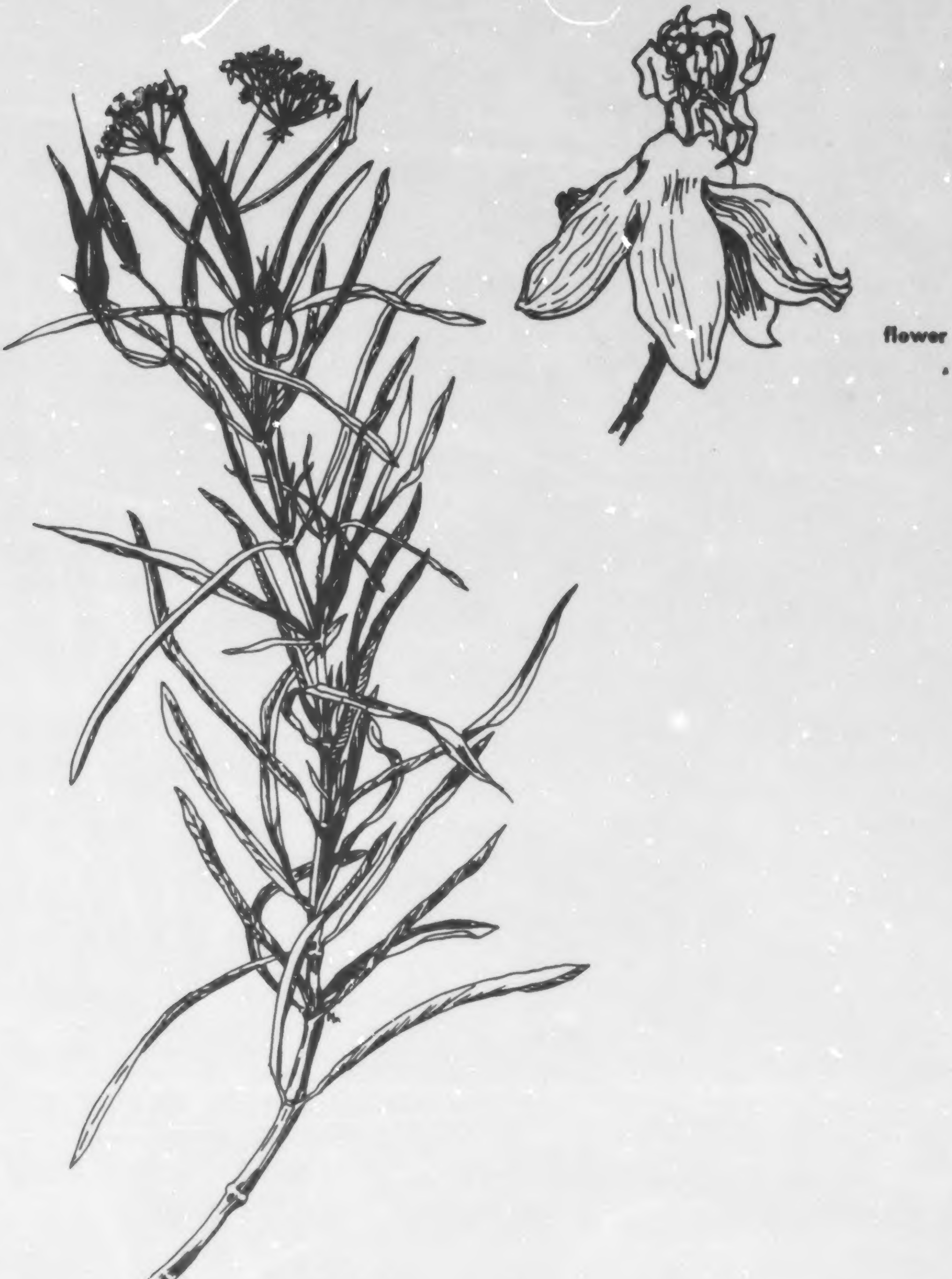
The milkweeds are perennial herbs of their own family (the Milkweed family). Two are important, one of the narrowleaf and the other of the broad-leaf type. Mexican milkweel (*A. fascicularis*) has very narrow leaves arranged in whorls. Woolypod milkweed (*A. eriocarpa*) has leaves up to 4 inches in width, wooly, and mostly opposite. The many flowers of both species are arranged in several groups, and each flower has a short stem. The flowers have five yellow or green-white petals. The seed pods are 2½ to 4 inches long and contain numerous seeds. The juice of the plant is milk-like in appearance and sticky.

The milkweeds are widely distributed but less common along the coast and the deserts. They occur mostly below 7,000 feet on dry, open sites and are associated with many plant communities.

Green milkweeds are distasteful to animals and are not eaten unless other forage is unavailable. Symptoms of poisoning usually appear about fourteen hours after animals eat the plants. The animals become weak, stagger, and the pulse is high and often weak. In severe cases, animals lose all control over leg muscles and fall down; respiration is labored. Attacks may last 24 hours during which time the animal's temperature rises sharply. Death may result if a mature sheep has consumed 1½ pounds of foliage or more and cattle over 5 pounds. The plants retain their toxicity when dry and are a menace in hay. Wooly-pod milkweed is considered more toxic than Mexican milkweed.



Woolypod Milkweed



Mexican Milkweed

Appendix F

DESCRIPTIONS OF IMPORTANT RANGE SHRUBS AND TREES

ASPEN

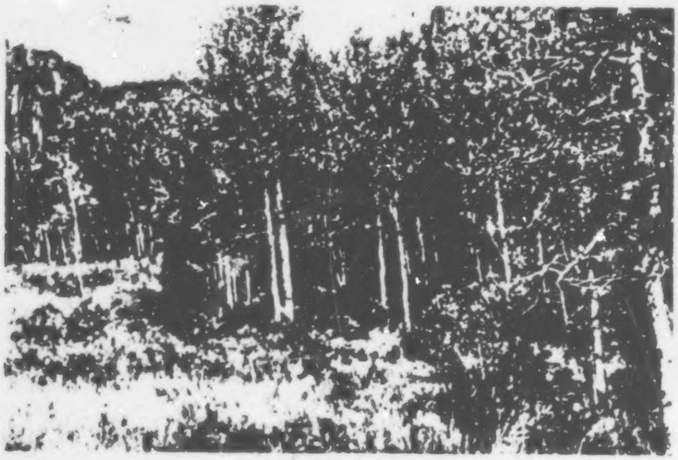
Populus tremuloides

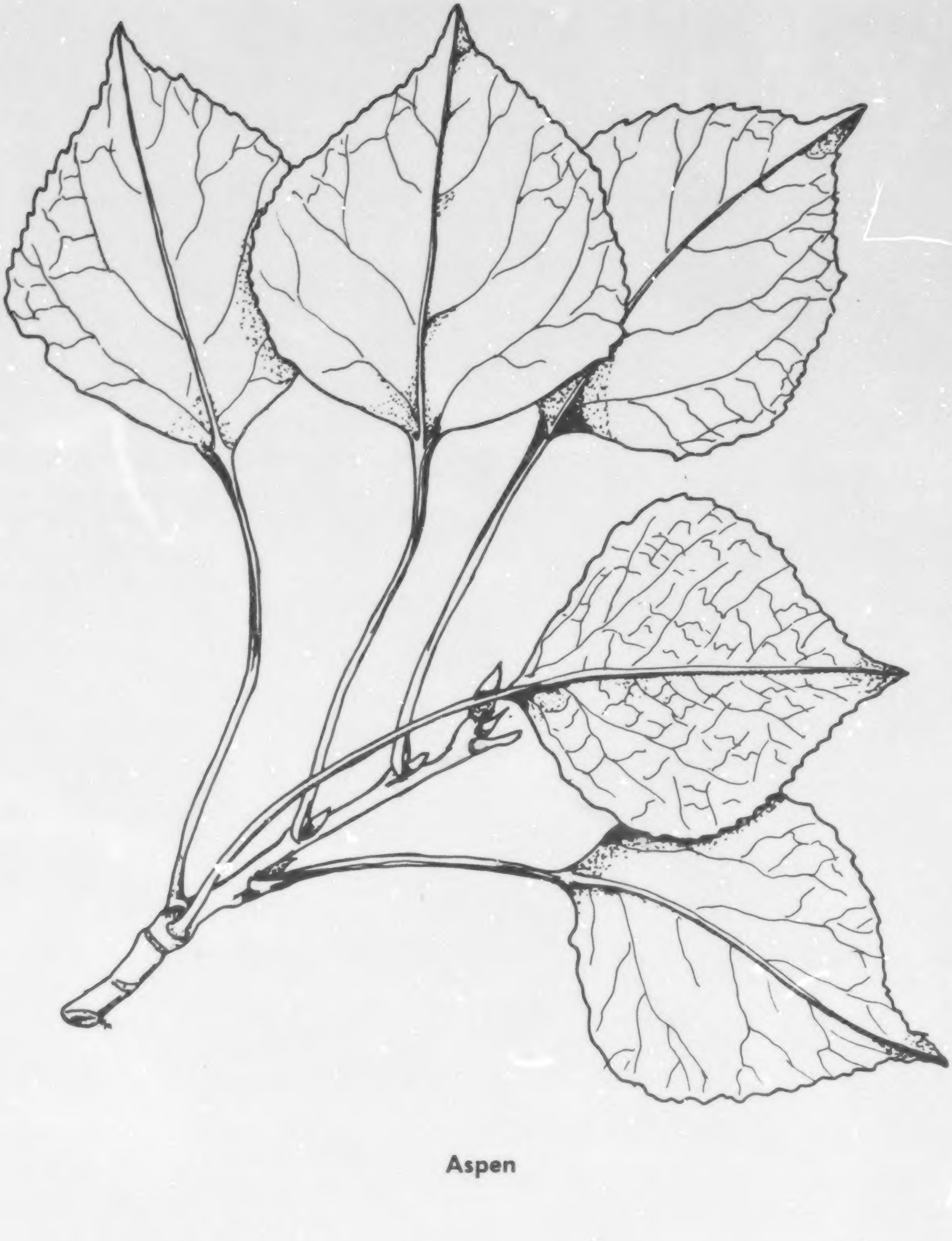
Quaking aspen is a small, deciduous tree up to 60 feet tall with cream or greenish-white bark becoming black-marked with age. The leaves on the flattened stalks are about 1 to 2 inches long and are arranged alternately on the stems. They are rounded and pointed at the tip, deep yellowish green and irregularly fine-toothed. As the lateral roots commonly form new shoots (sprouts), the trees develop into rather isolated groves. Abundant, viable seed is produced each year.

This tree is frequent above 5,000 feet and borders meadows, streams, and moist slopes. Thickets occur in openings among fir and lodgepole pine, and usually contain a variety of forage species.

Quaking aspen is considered as fair to good forage for cattle and sheep. The leaves, young twigs, and new root-shoots are relished by stock both in summer and fall. Young leaves contain about 18 percent crude protein. The foliage is important browse for deer and is a key summer food. Deer eat the fallen leaves in autumn and the barren stems during the winter. The flowers and buds are eaten by grouse in the spring.

On ranges heavily grazed by livestock and deer, "high-lining" is evident, and seedlings and root sprouts are conspicuously missing. Open stands without reproduction are found around stock watering areas and wherever herbaceous forage is over-used. Aspen is easily damaged by fire and close browsing, but reproduces quickly by sprouting and seed if protected.





Aspen

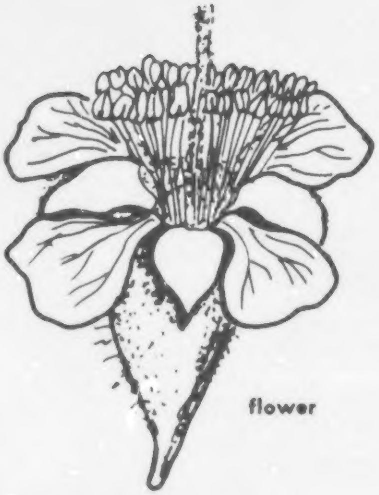
BITTERBRUSH

Purshia tridentata

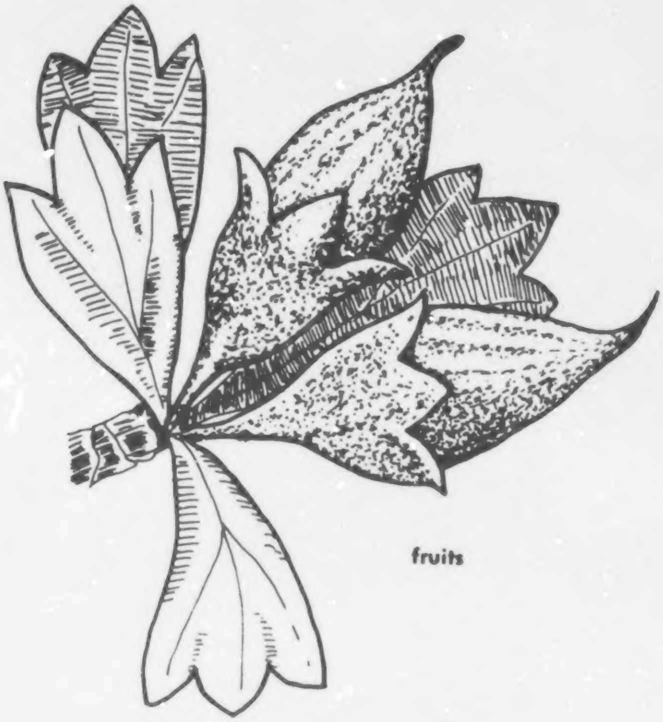
Antelope bitterbrush is an erect, widely branched, silvery-green shrub. It usually grows 2 to 6 feet high but sometimes attains a height of 15 feet. The bark is grey or brown and the young branches are covered with fine hairs. The deciduous leaves are alternate, wedge-shaped, ¼ to 1 inch long, and three-lobed or toothed at the tip. The upper surface of the leaf is covered with fine hairs, and the lower surface is densely white-hairy. The flowers are pale yellow and are usually borne singly on short branchlets. The flowering period is from April to May. The fruits are leathery, brown or black, and about ⅝ inch long.

Bitterbrush is found between elevations of 3,500 and 11,500 feet. It is commonly associated with sagebrush and pine on dry sites of the Intermountain region.

Bitterbrush is readily eaten by livestock and deer. On some winter ranges, it furnishes the bulk of the livestock feed and is the major source of deer browse. The leaves and current twigs, with a protein content of 10 to 15 percent, supply very nutritious forage. The shrub is especially valuable because it provides green forage four to six weeks longer in the fall than most grasses and forbs. Over much of its range, stands have been depleted by fire, overbrowsing, insects, drought, or a combination of these factors. Often plants are browsed so closely that no seeds are produced. Because natural reestablishment is slow, much work has been done to reseed antelope bitterbrush.



flower



fruits

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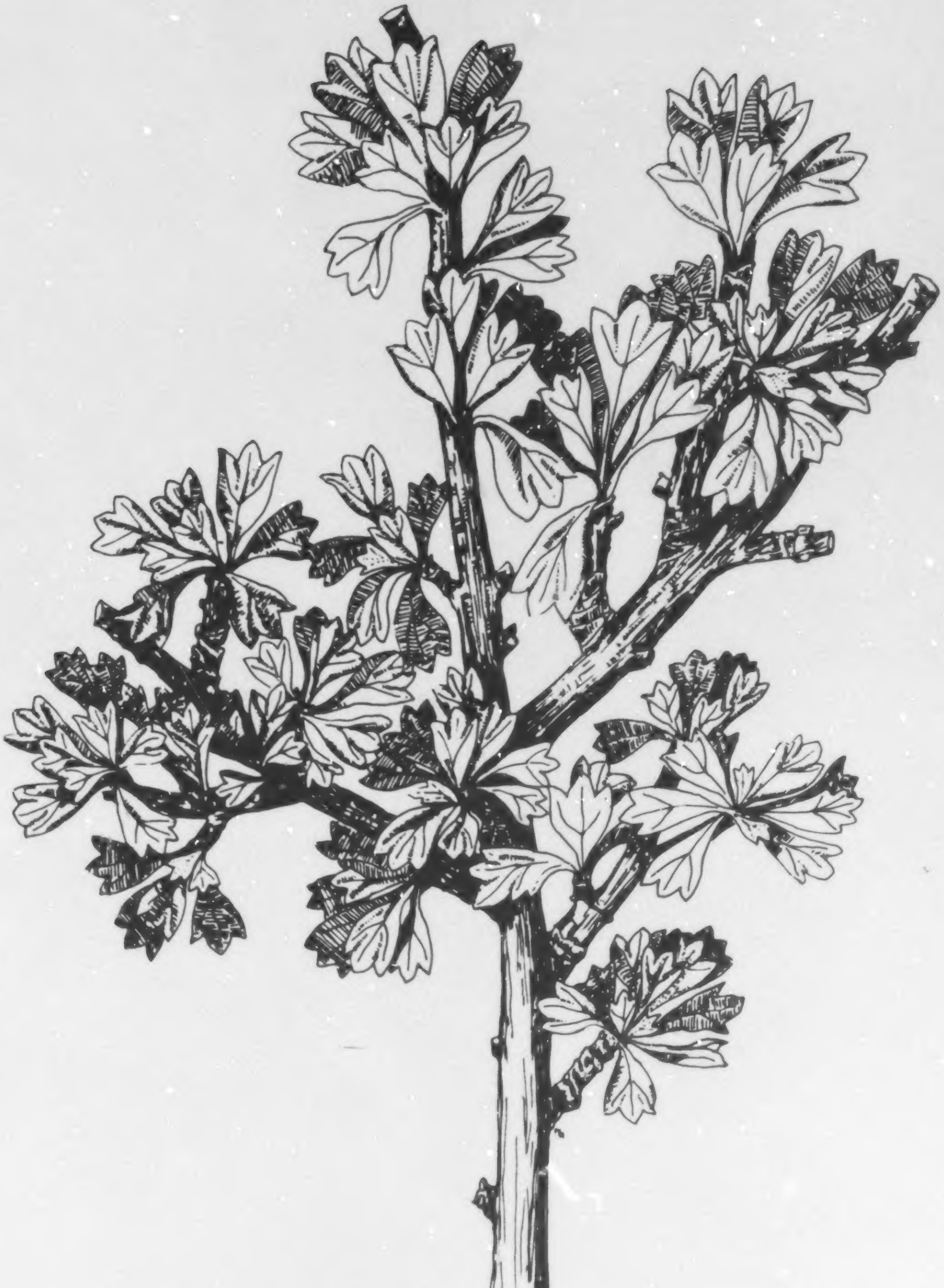


Bitterbrush

CEANOTHUS

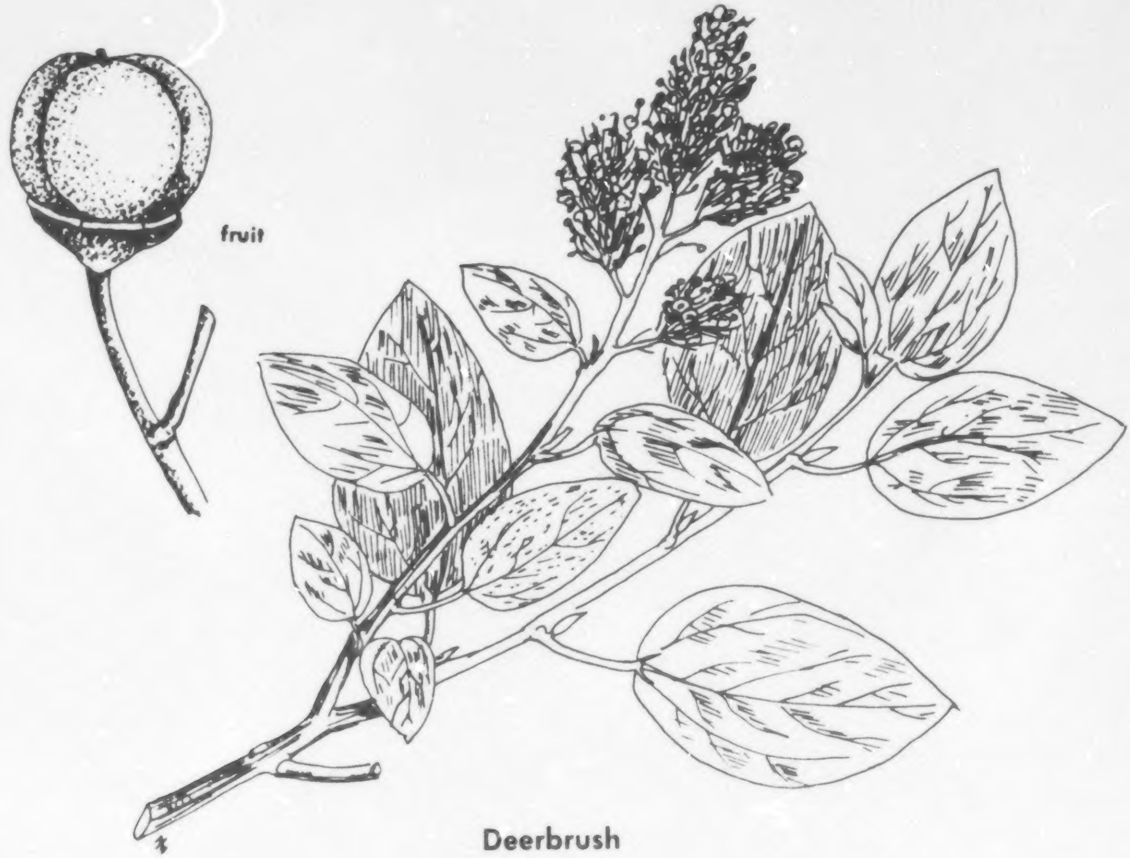
Ceanothus spp.

Ceanothus is both the genus and common name for numerous related shrub species. Wedgeleaf ceanothus (*C. cuneatus*) and deerbrush (*C. integerrimus*) are considered the most important and representative species. Both are sometimes called "buckbrush."

Wedgeleaf ceanothus is common to California, Oregon and western Nevada. It is an erect shrub 3 to 12 feet tall with rigid, spreading branches and short, stout, unequal branchlets. The wedge-shaped, evergreen leaves are less than one inch long, dull green and have a prominent middle vein. Flower clusters are usually white, but sometimes have a bluish tint. The fruit is a rounded capsule with three parts, each with a small horn.

The stiff twigs and thick leaves of wedgeleaf ceanothus are seldom eaten by livestock, so it is rated as poor forage. However, the leaves and tender new twigs are an important browse for deer during the winter. Rabbits, quail, and many rodents eat the seeds. The plants do not sprout from the crown, and reproduction depends on germination of seed which seldom sprouts successfully except after a fire.

Deerbrush or sweet birch, is a loosely branched, deciduous shrub with slender,

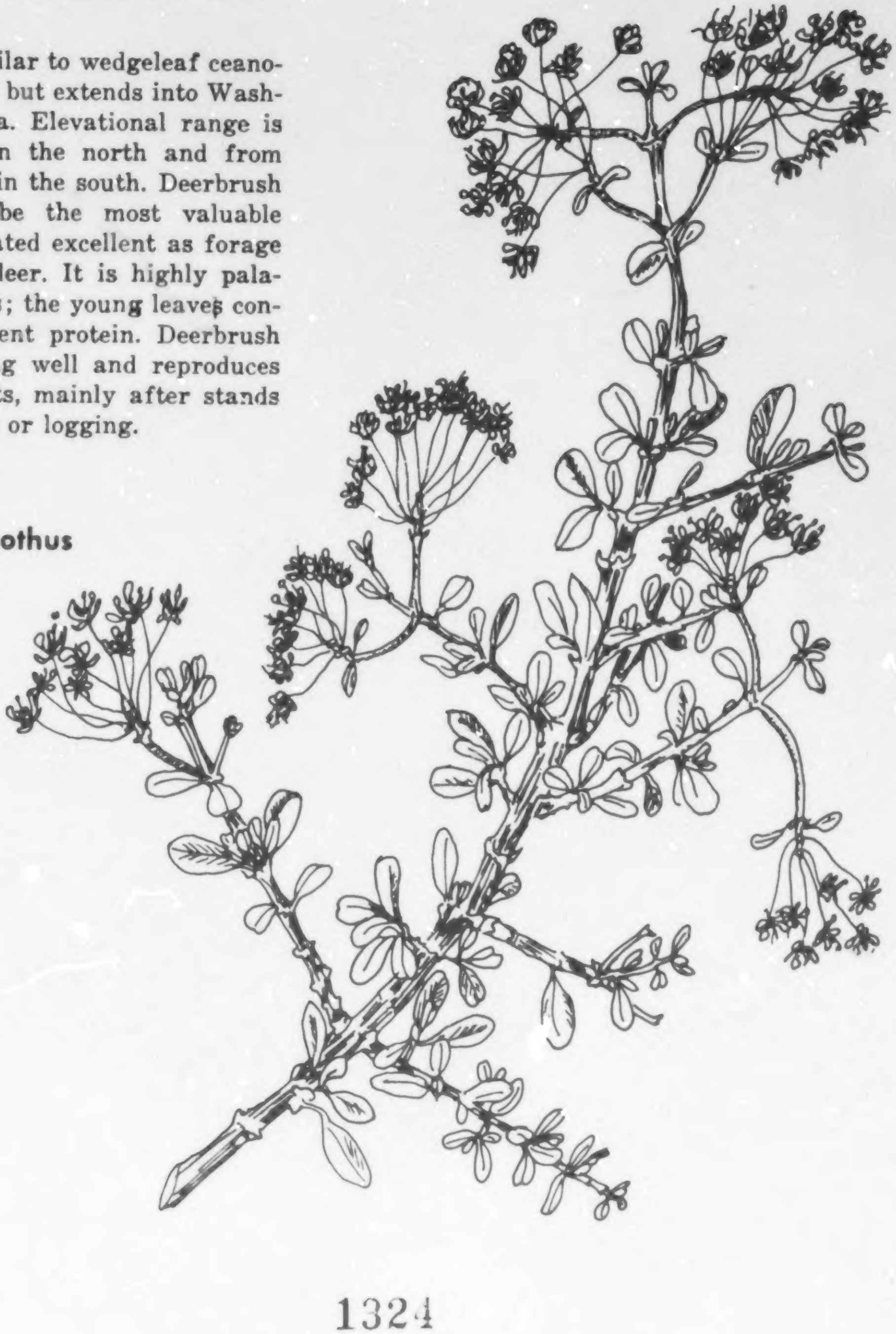


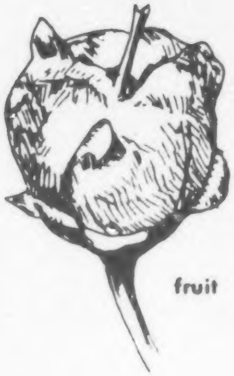
Deerbrush

drooping branches from 4 to 18 feet high. Leaves are soft and thin, oval in shape, and have three prominent mid-veins. They are alternate on the stems, light green, and from 1 to 3 inches long. The flowers are borne in white or bluish clusters and the small, round seeds are produced in a capsule similar to wedge-leaf ceanothus but without horns.

Deerbrush is similar to wedgeleaf ceanothus in distribution but extends into Washington and Arizona. Elevational range is above 2,000 feet in the north and from 5,000 to 7,000 feet in the south. Deerbrush is considered to be the most valuable ceanothus and is rated excellent as forage for livestock and deer. It is highly palatable and nutritious; the young leaves contain 20 to 25 percent protein. Deerbrush withstands browsing well and reproduces by seed and sprouts, mainly after stands are thinned by fire or logging.

Wedgeleaf Ceanothus





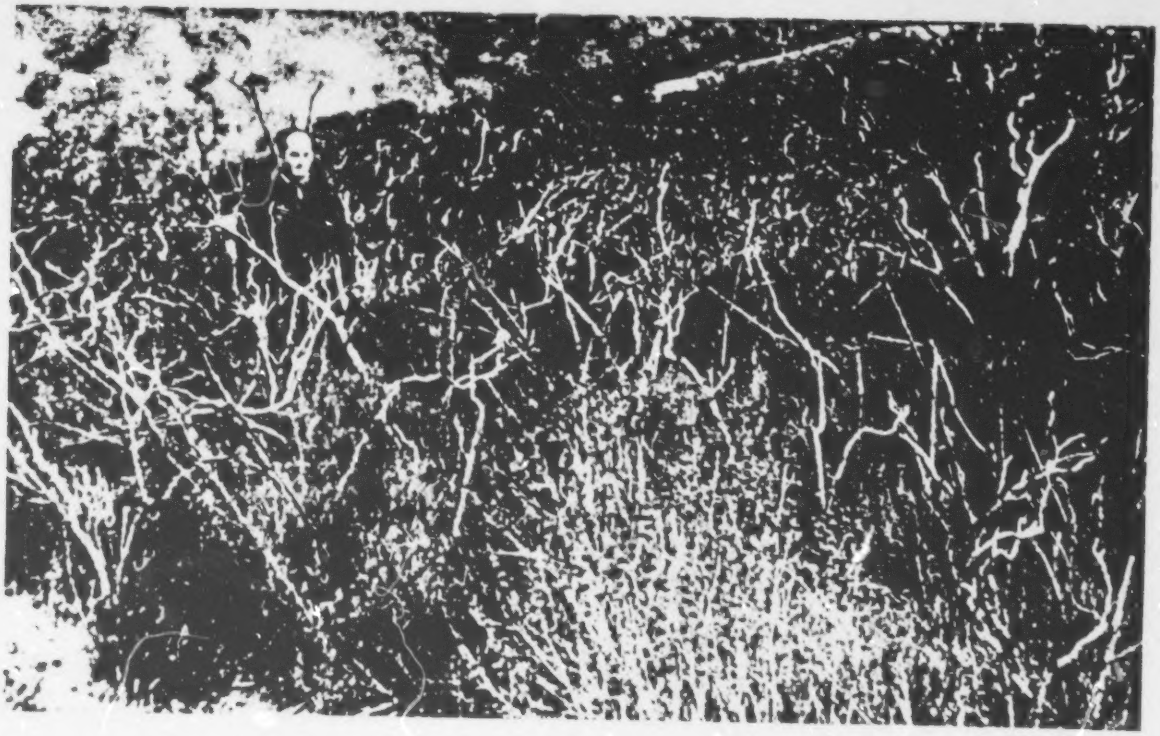
CHAMISE

Adenostoma fasciculatum

Chamise is a diffusely branched, evergreen shrub 2 to 12 feet high with a well-developed, enlarged root crown. The bark on young twigs is red, becoming shredded and gray with age. The leaves are small and narrow, ¼ to ½ inch long, alternate or in clusters. Flowers are white and numerous in dense clusters at the ends of branches.

Chamise is perhaps the most common shrub on many millions of acres of California chaparral. Occurring mostly below 5,000 feet on dry slopes, it extends through the Coast Ranges, the mountains of southern California and the lower Sierra Nevada and Cascades. It usually forms dense stands which may be nearly impenetrable to man or animals. Seedlings are rare except after a fire.

Chamise is an important source of deer browse, because its evergreen leaves furnish browse when other vegetation is dry. Deer prefer the young sprouts and seedlings but also strip the leaves from mature plants. Mature plants are largely unpalatable to livestock, but young crown sprouts and seedlings following fire are browsed to some extent. In the spring, crude protein of new growth is about 14 percent. This declines to around 6 percent in the fall. After fire, a majority of the plants sprout from the root crowns and seed germination is stimulated by burning, so, many seedlings also appear. It is able to grow well on very poor sites and for this reason, it represents valuable watershed protection.



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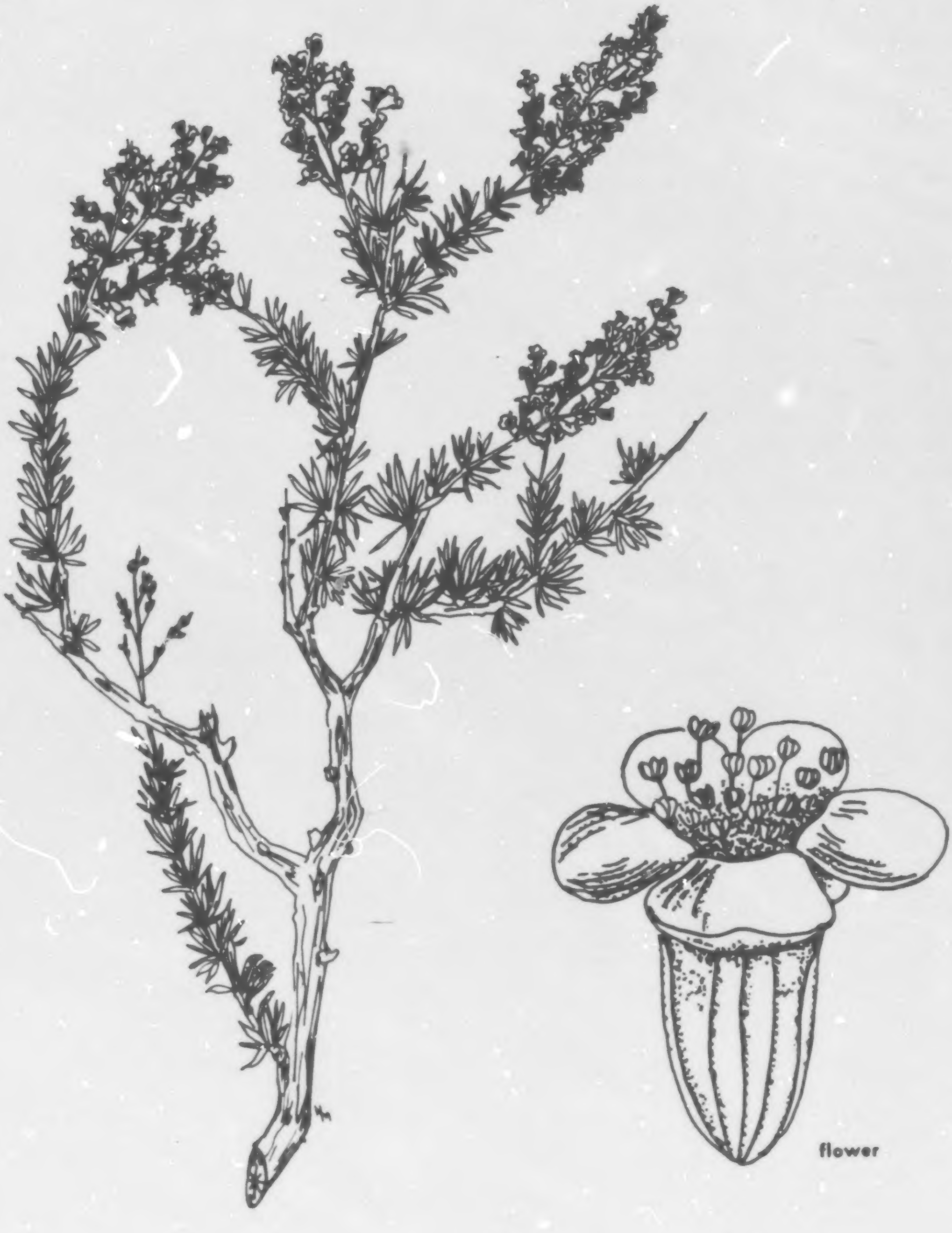


Chamise

1326

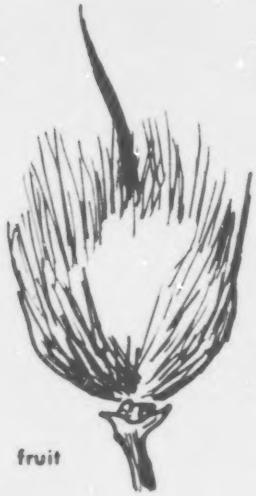
CREOSOTE BUSH

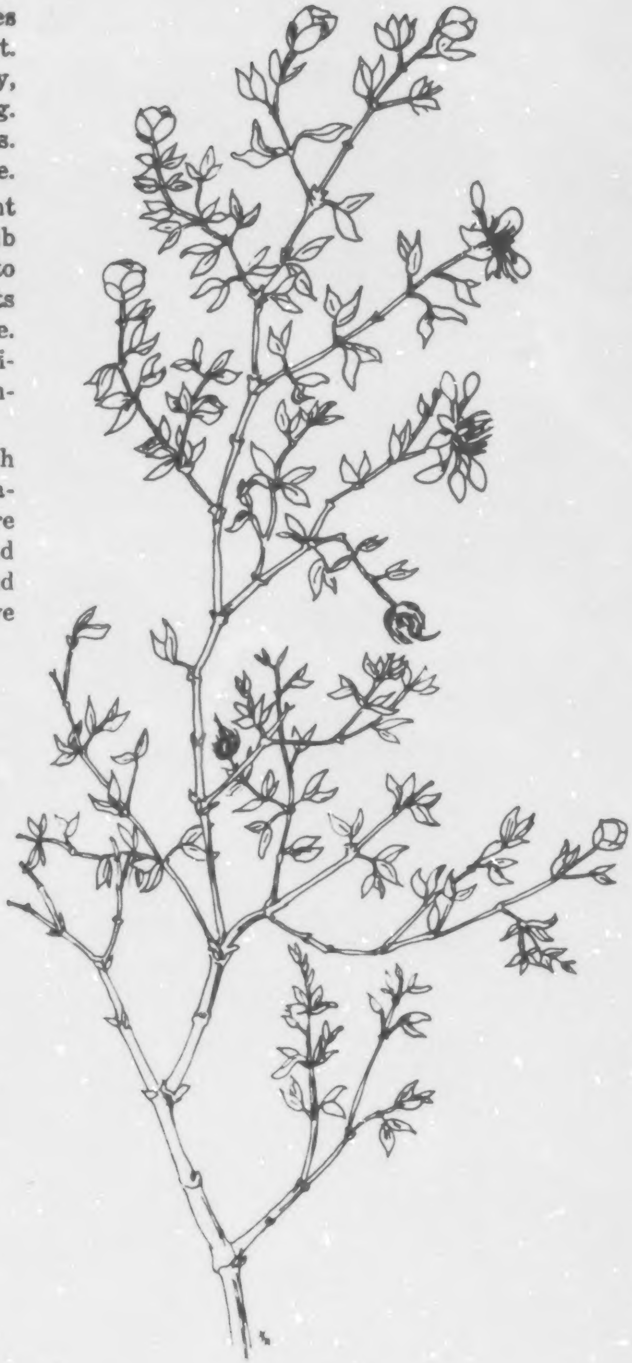
Larrea divaricata

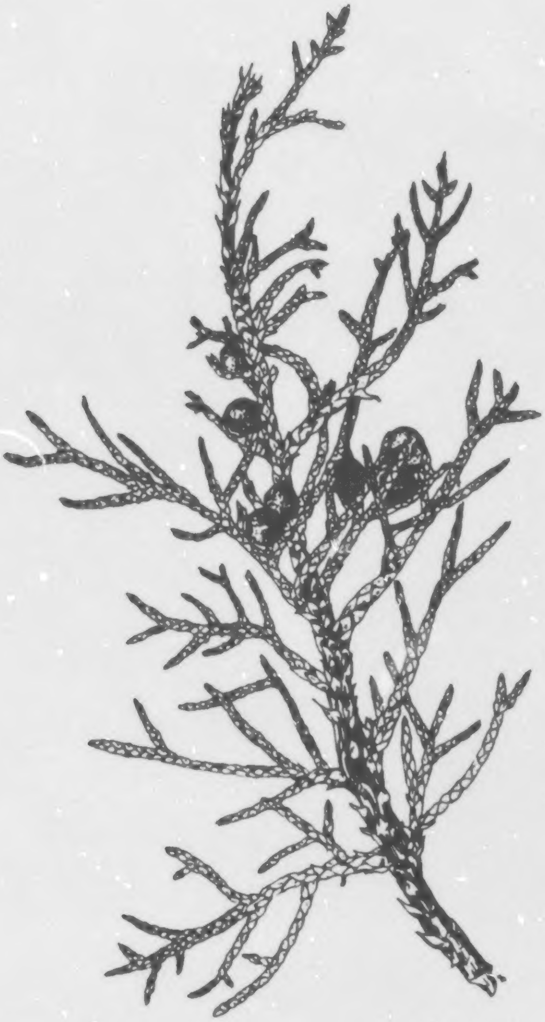
Creosote bush is an evergreen, brittle shrub with many dark colored branches reaching to heights of from 3 to 12 feet. Its leaves are divided into two shiny, sticky, bright green leaflets about ½ inch long. The flowers have five bright yellow petals. An odor of creosote is typical of the foliage.

Creosote bush is the characteristic plant on millions of acres of the desert shrub type in California, Arizona, and south to Mexico. It is important because of its adaptation to the desert and its abundance. Creosote bush occurs in nearly pure, uniformly spaced stands extending for hundreds of square miles.

This desert bush is not associated with forage species and is completely unpalatable. Its seed and protective cover are valuable to jack rabbits, small rodents, and quail. The foliage is highly flammable, and a variety of medicinal concoctions have been made from it.


fruit





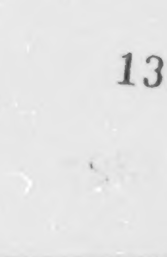
JUNIPER

Juniperus spp.

The junipers are evergreen trees of variable shape from 2 to 60 feet tall having large, spreading branches. The gray-green, needle-like leaves are in groups of two or three, closely attached around the branchlets. Male flowers form cones, and fruits are rounded or egg-shaped berries about ¼ to ½ inch in diameter. Each berry is reddish-brown or blue-black in color and covered with a powdery "bloom." They are pulpy, and have one to three seeds. All of the foliage is resinous and strongly scented.

The junipers are found at elevations from 2,500 to 10,500 feet on dry sites of foothill and mountain ranges in all of the western states, especially in the Southwest. They frequently occur with big sagebrush and jeffrey pine.

The junipers are useless as forage for cattle and horses, and are only slightly palatable to goats and sheep. However, foliage and fruit constitute a source of winter browse for deer when other feed is scarce. Antelope also are known to eat twigs and foliage, and a variety of birds including grouse, quail, doves, small mammals, coyote, and fox eat the berries. The seed is usually excreted unharmed to spread the species further. Juniper trees are cleared for range improvement and the wood is used for fence posts and firewood.



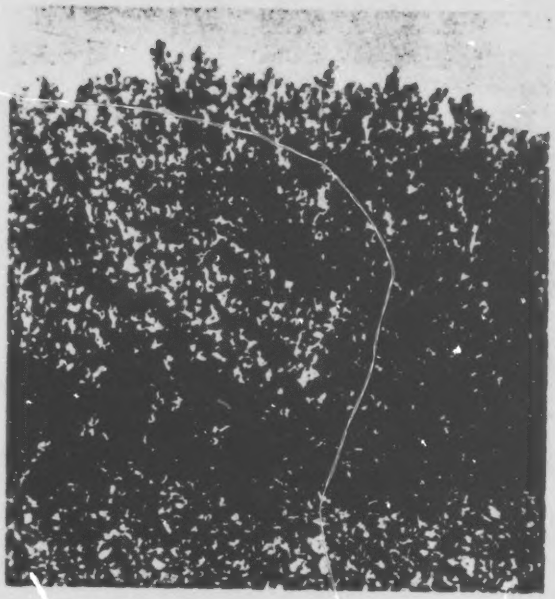
fruit

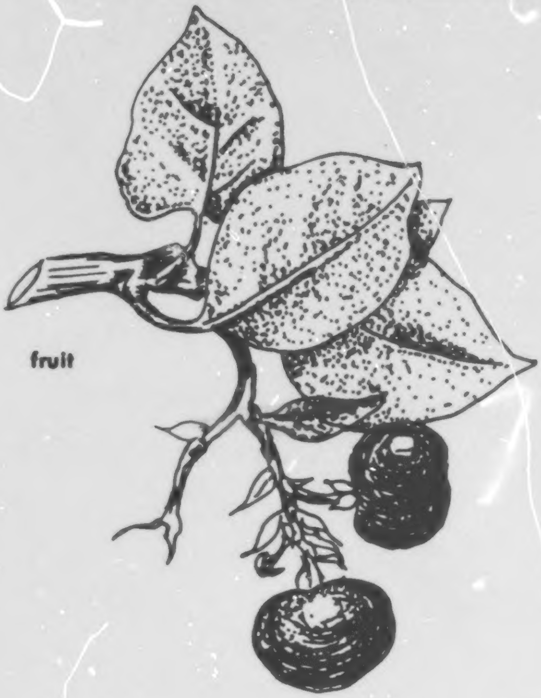
MANZANITA

Arctostaphylos spp.

Manzanita as a genus is easily recognized, but it is difficult to identify the numerous species and varieties. All species of manzanita are erect shrubs or tree-like shrubs from 2 to 20 feet tall having crooked branches with smooth, reddish-brown bark. The simple evergreen leaves are from 1 to 1¾ inches long, rounded or egg-shaped, and alternately arranged. The flowers are white or light pink and arranged in clusters. The maroon-colored, berry-like fruits have several hard nutlets covered by a pulp. The name "manzanita" is a Spanish word meaning "little apple" which describes the fruit, commonly ¼ to ½ inch in diameter.

The manzanitas inhabit well-drained, warm soils of low productivity on chaparral ranges of the southwestern range states. None are an important forage resource for domestic stock, nor are they rich in protein. The dense, rigid, highly-branched structure of manzanita makes them unwanted on livestock ranges. On better sites having associated forages, manzanitas are frequently the object of brush control efforts. Deer browse only the young, tender sprouts in the early spring or after recent burns, and eat the foliage and twigs in winter. Grouse, fox, skunks, and small mammals eat the berries, as well as using the dense cover provided by the manzanitas.





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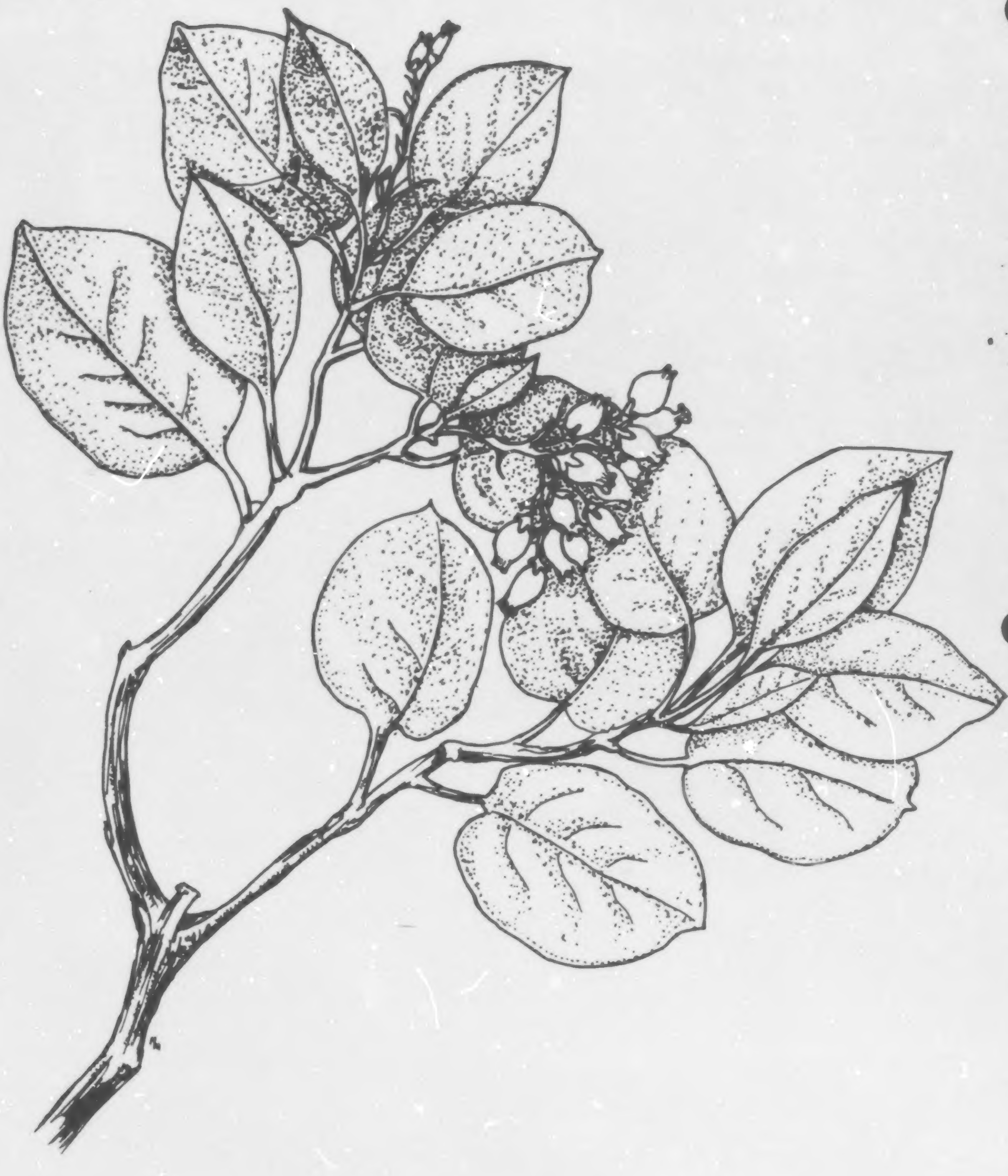


Manzanita

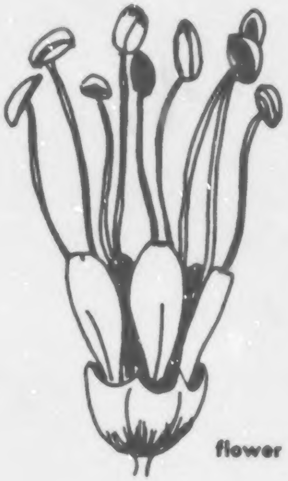
1330

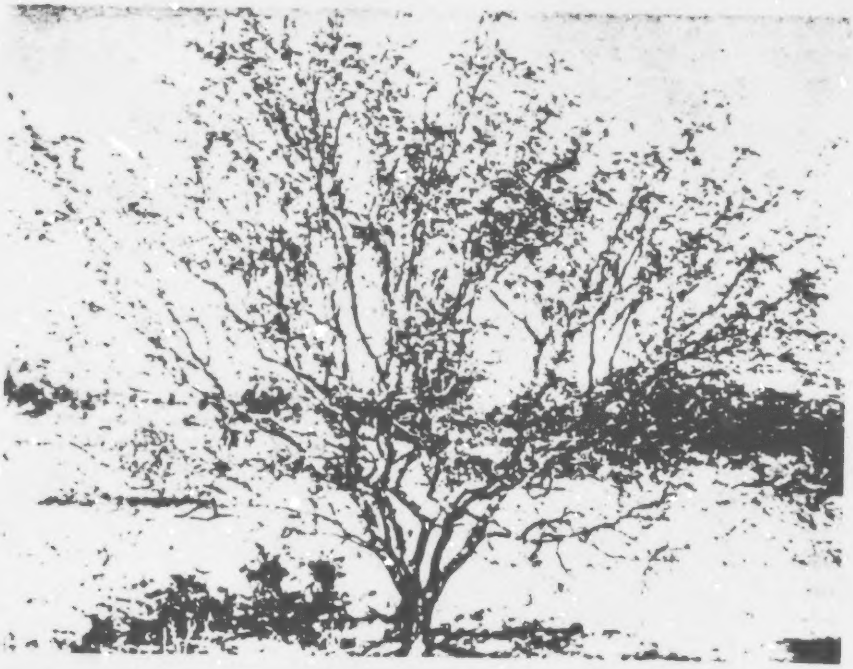
MESQUITE

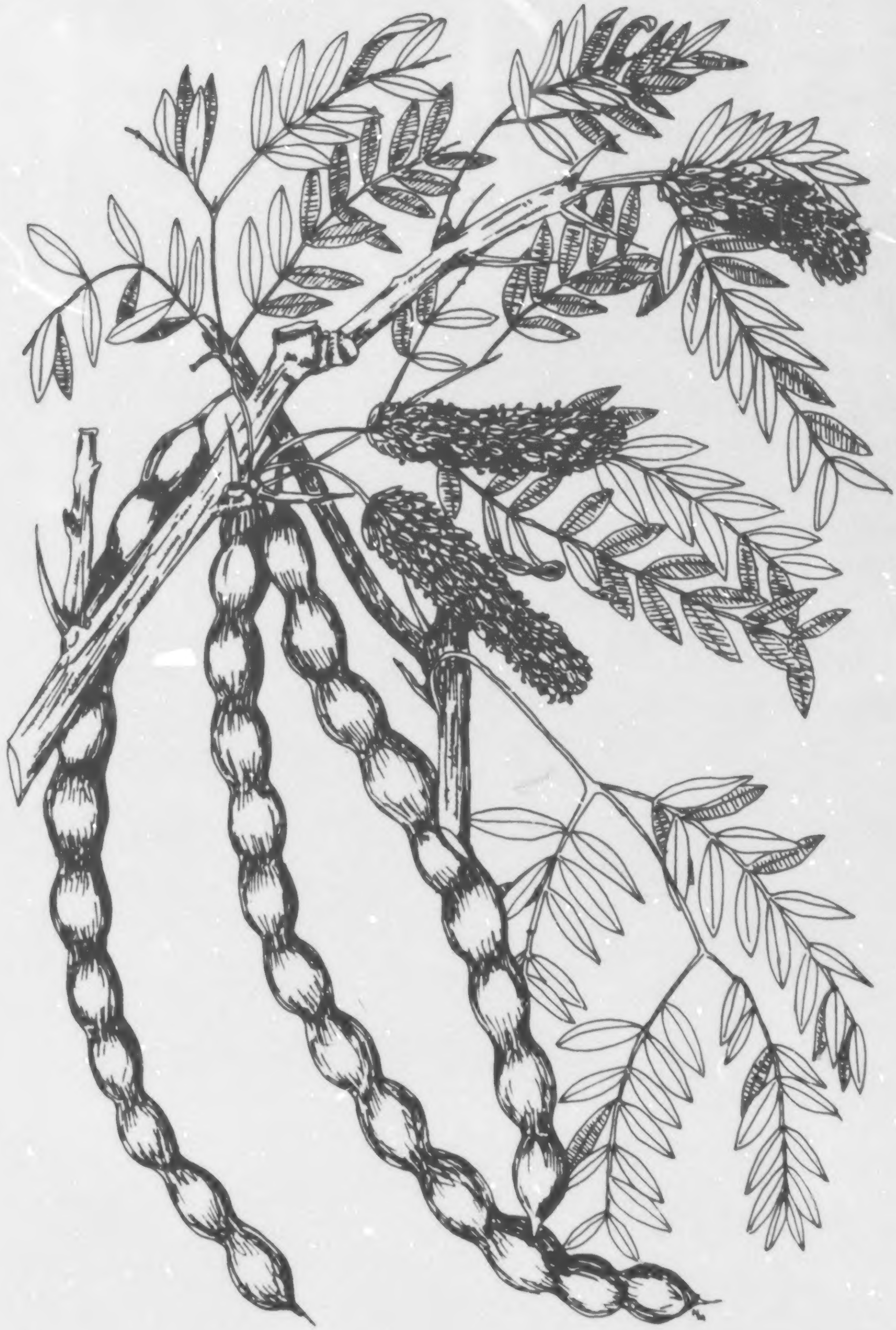
Prosopis juliflora

Common mesquite is a branchy shrub of the southern desert states. It is sometimes called honey mesquite, but is a separate variety. Mesquite grows 5 to 30 feet tall and has compound leaves divided into dark green, smooth, pointed leaflets. The leaf stalks are armed with spines. Flowers have five pale green petals and are arranged in dense spikes. The seeds are in drooping, flattened pods about 4 to 8 inches long which do not split open at maturity.

Mesquite grows on dry, sandy sites at elevations up to 5,000 feet from Texas to southern California and southward. All kinds of livestock, big game, and small mammals eat the nutritious pods throughout the summer. Young twigs and leaves are browsed in the spring. Mesquite is generally considered a good forage, primarily because of the pods, and provides excellent wood for fences and other purposes. Mesquite has increased greatly in areas where grasses have been overgrazed or fire has been prevented.







Mesquite

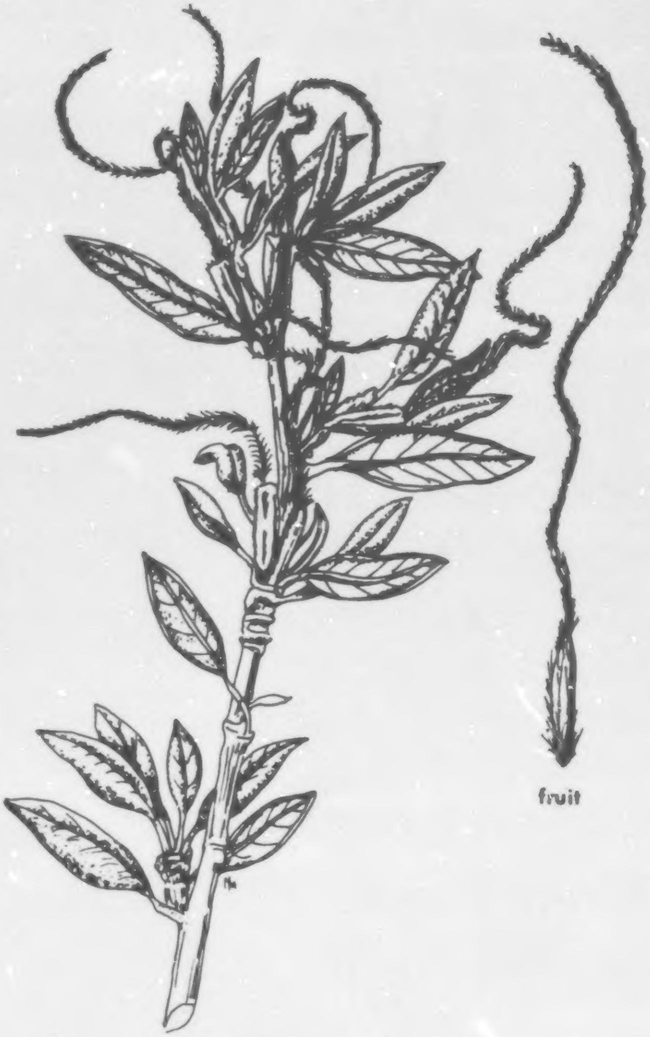
MOUNTAIN MAHOGANY

Cercocarpus spp.

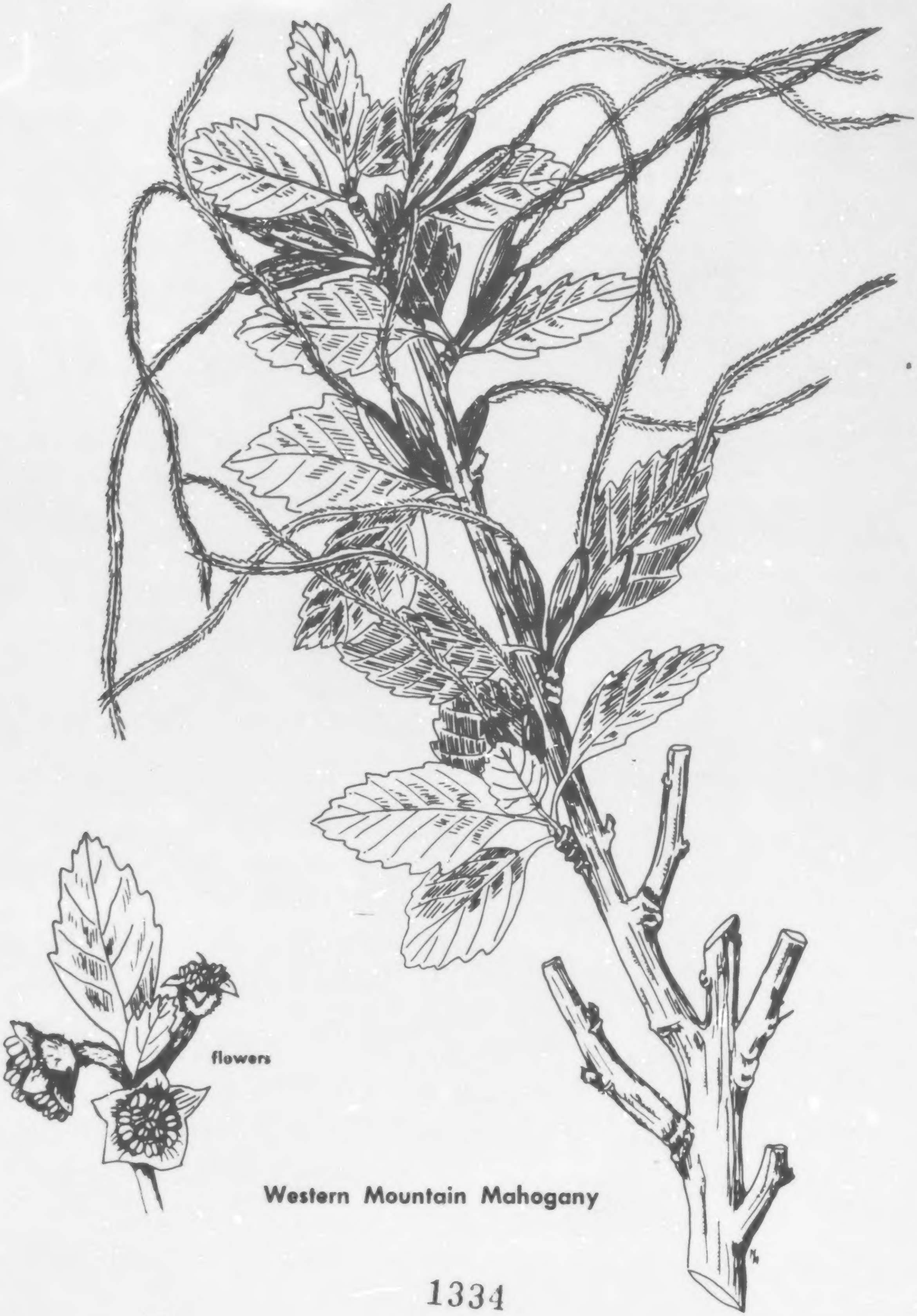
Two species of mountain mahogany are especially common, western mahogany (*C. betuloides*) and curl-leaf mahogany (*C. ledifolius*). Both are loosely spreading tree-like shrubs from 5 feet to as much as 30 feet tall. Leaves are ½ to 1 inch long and usually clustered on short branchlets. Flowers are in clusters of two or three, and each forms a hairy fruit topped by a twisted, hairy plume (style) from 2 to 3½ inches long. The leaves of western mountain mahogany are oval and toothed near the ends. Those of curl-leaf are lance-shaped and the edges smooth and wavy.

Both species prefer dry, rocky slopes, and are found in the mountains at elevations of 4,000 to 10,500 feet. They are commonly found with oak, juniper, ceanothus, and pine.

Western mountain mahogany is excellent browse for cattle, sheep, and deer. Both leaves and recent twig growth are palatable and furnish feed year round. Crude protein content is between 7 and 15 percent. Curl-leaf is browsed by deer and antelope in all but the summer months. It has the same nutritional value as western mountain mahogany but is not readily eaten by domestic stock. Mountain mahogany produces large amounts of seed in favorable years, and most seed germinates the following spring. Unless restricted to a shrub form by browsing or fire, older mahoganies soon develop a tree-like form with foliage out of reach of animals.



Curleaf Mountain Mahogany



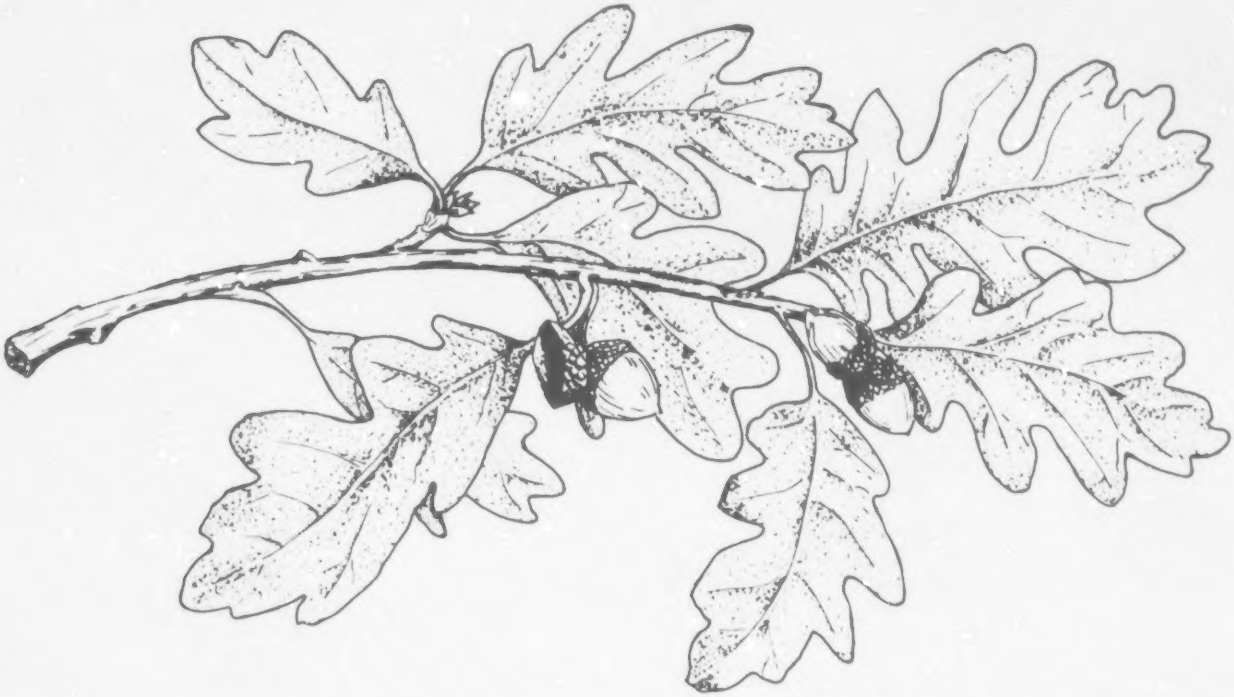
Western Mountain Mahogany

OAK

Quercus spp.

The oaks are common trees on chaparral and woodland ranges. Depending on the species and site conditions, they vary from low shrubs to magnificent trees. The simple, alternate leaves are toothed or lobed, and attached singly on the branches. Some oaks shed their deciduous leaves each year, but the leaves of evergreen species persist for two or three years. The flowers are very small and green. The male flowers are hanging tassels, and the females are in clusters at the base of young leaves. The fruits are acorns requiring one or two seasons to mature in the autumn. Nearly all of the oaks produce sprouts after cutting or burning.

Palatability of oak foliage varies with the species, season, and animal. New growth is preferred, and the foliage of deciduous oaks is more palatable and nutritious than that of the evergreen species. The acorns of all oaks are a basic feed in fall and winter for deer, doves, quail, turkeys, squirrel, and a variety of other birds and small mammals. Although the acorns are relatively low in protein, they are high in energy-giving fat and carbohydrates. Both the foliage and acorns are eaten by livestock but are considered only fair as forage. They are high in resins, waxes, and tannins which may harm livestock if consumed as a large proportion of their diet.



Gambel Oak

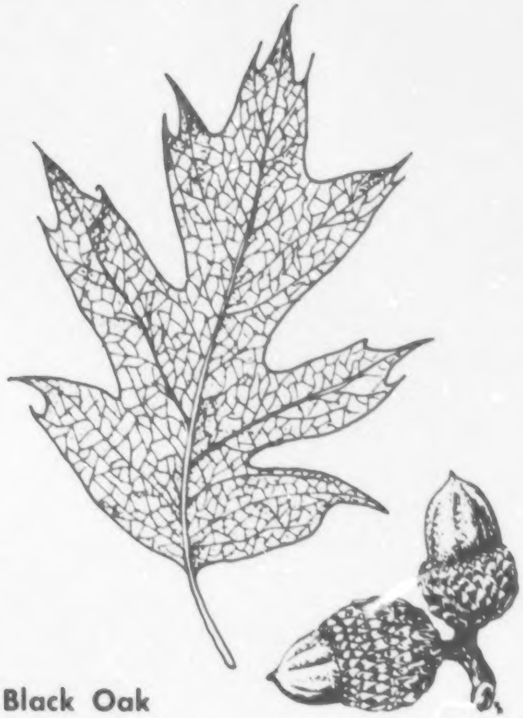
Of the numerous species of oak found on our ranges, three oaks are included here which are common on foothill-chaparral and woodland-grass ranges.

Black oak (*Q. kellogii*) is a deciduous tree from 30 to 80 feet high with bright green leaves, 3 to 10 inches long. The leaves are divided into five main lobes, each with one to three bristled teeth.

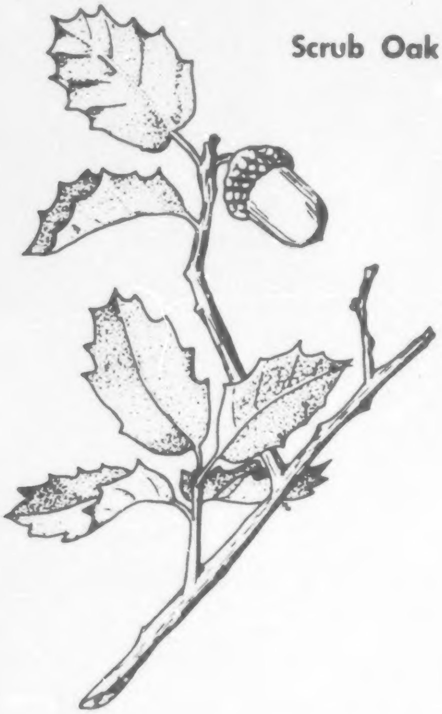
Acorns ripen in two years and are from 1 to 1½ inches long. This oak is mainly a mountain species found from 1,500 to 8,000 feet within pine and fir forests.

Scrub oak (*Q. dumosa*) is usually a small, dense shrub 2 to 6 feet high with white bark. The leathery leaves are ½ to 1 inch long with spiny edges and velvet hairiness below. Acorns are ½ to 1 inch long and mature annually. Scrub oak is typically a southwestern oak of foothills under 6,500 feet on chaparral and desert-shrub ranges.

Gambel oak (*Q. gambellii*) is a small tree or shrub of the central and southern range states. The deciduous leaves are bright, shiny green above and dull green below, and from 2 to 4 inches long. The deep lobes are irregularly shaped and rounded. The acorns, produced annually, are about ½ inch long.



Black Oak



Scrub Oak

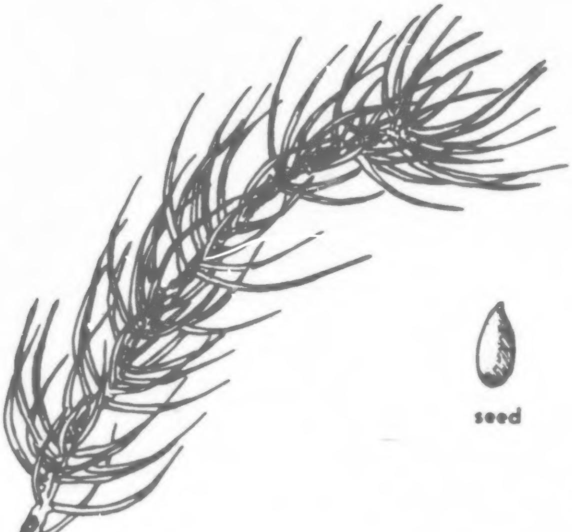
PINE

Pinus spp.

The pines are easily identified by most observers as evergreen trees bearing cones and needle-like leaves either singly or in clusters. The woody cones vary in size. The cone scales are thickened at the outside, and each bears two winged seeds. Three species are common on livestock ranges, pinyon (*P. monophylla*), jeffrey (*P. jeffreyi*), and ponderosa (*P. ponderosa*). All grow on foothill and mountain ranges on well-drained soils.

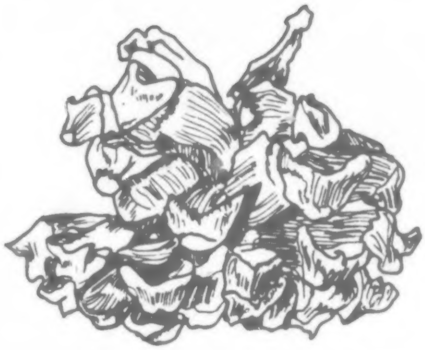
Pinyon or single-leaf pine is a small, flat-topped tree from 15 to 50 feet tall. Needles are 1 to 1½ inches long, arranged singly on the branches. Cones are about 1½ to 2¼ inches long and bear large edible seeds called "pine nuts." Pinyon is scattered on the mountains of the southwestern range states at elevations from 3,000 to 9,000 feet. It is associated with juniper over much of its range.

Pinyon Pine



needles

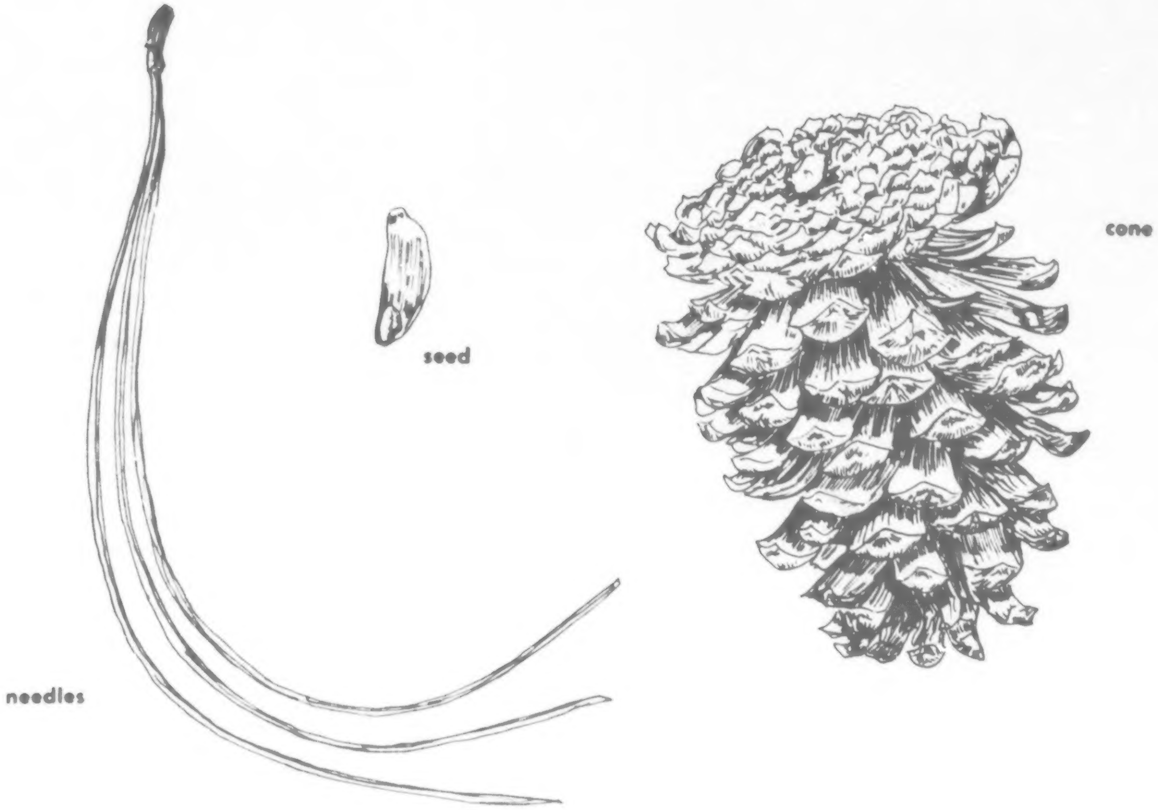
seed



cone

Ponderosa and jeffrey pine are closely related and occur at elevations of 2,000 to 9,000 feet throughout the western coniferous forests. Ponderosa is more common in areas of higher rainfall, and jeffrey pine grows on drier sites. Both are timber species with clusters of three needles up to 10 inches long. Jeffrey cones are usually over 6 inches long; ponderosa cones under this length.

These species form a canopy on grass ranges over much of their range and are useful for shade. Seed is valuable to small mammals, birds (grouse especially) and occasionally livestock. The needles are browsed in the winter by deer. They are not readily grazed by livestock and may cause abnormal calving if eaten by cows during late pregnancy.



Ponderosa Pine

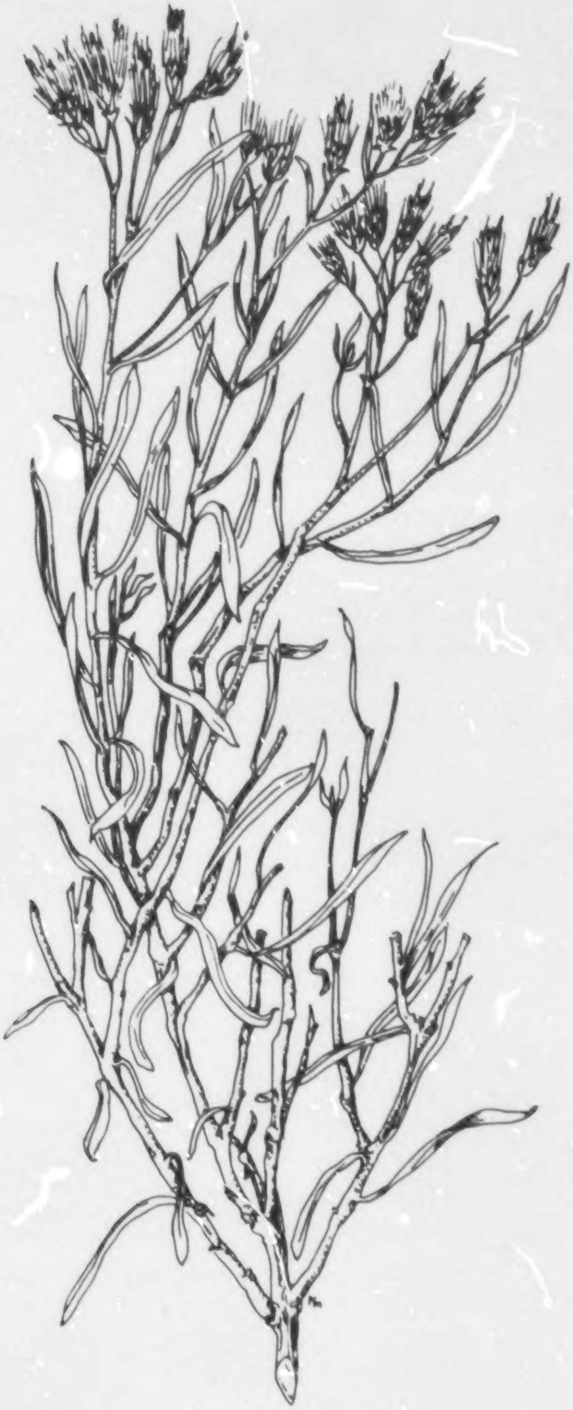
RABBITBRUSH

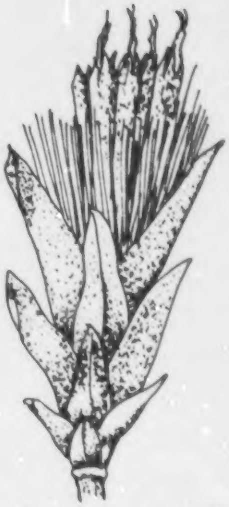
Chrysothamnus spp.

Rabbitbrush is an evergreen shrub 1 to 8 feet tall with several erect stems from the base and flexible, moderately leafy branches. The simple leaves are ¾ to 2½ inches long, very narrow, and arranged alternately on the stems. The flower heads are in terminal clusters, each head containing five to six flowers producing five-sided seeds. Two common species are rubber rabbitbrush (*C. nauseosus*) and green rabbitbrush (*C. viscidiflorus*). Rubber rabbitbrush has leaves covered with a mat of white velvet. Green rabbitbrush has smoother, bright green, twisted leaves.

There are several forms of these two species, all of which prefer deep gravel or alkaline soil of drainage areas. They are found from 500 to 9,500 feet on sagebrush and desert shrub sites of the Intermountain range states.

Domestic livestock browse small amounts of rabbitbrush only when other forage is scarce in the fall and winter. Deer, antelope, and jack rabbits get a large part of their winter diet from the shrubs in some localities, perhaps because it is so abundant. In most areas, however, it is not eaten by game animals and constitutes only a small part of the feed taken. Protein content varies from 9 percent in winter to 12 percent in young spring foliage. Rabbitbrush is an indicator of depleted rangeland or disturbed soils where it grows in dense stands.





Rubber Rabbitbrush

SAGEBRUSH

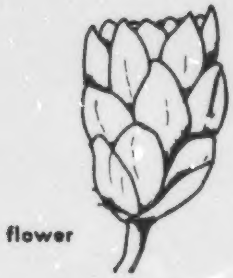
Artemisia spp.

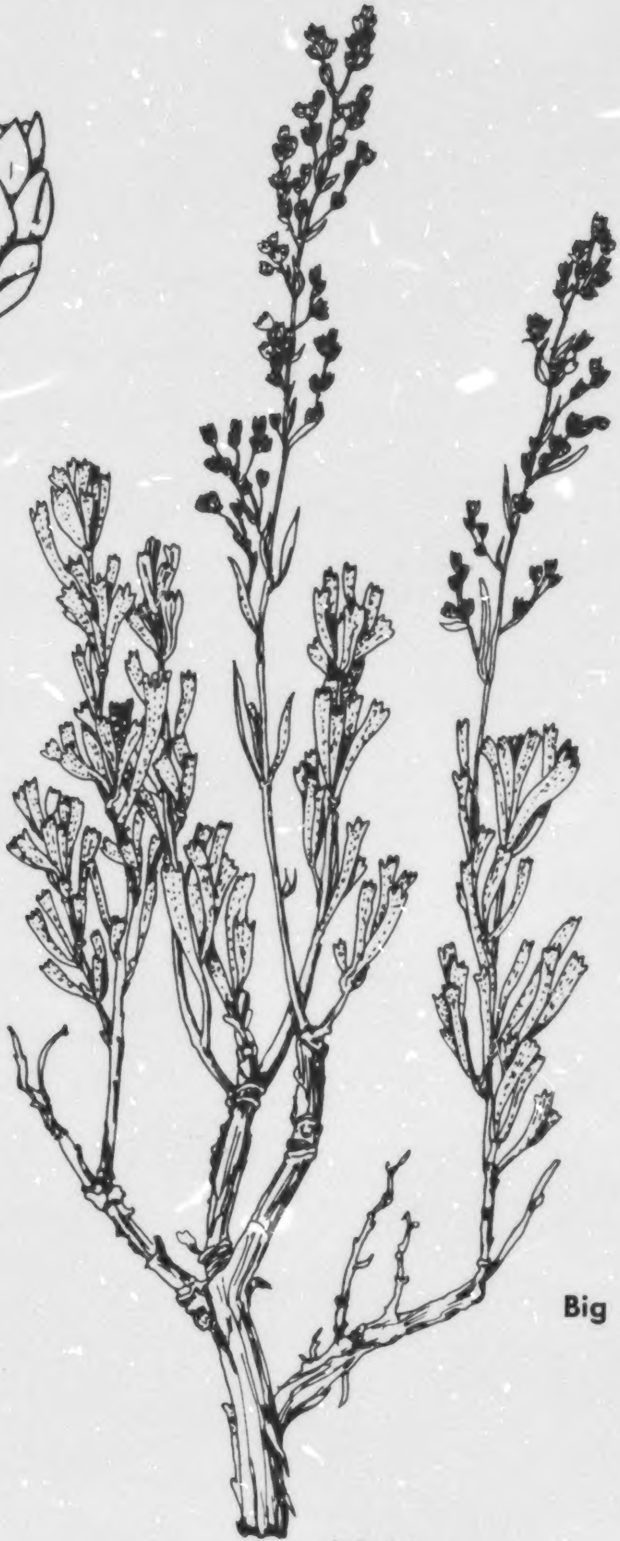
The terms "sagebrush" and "sage" are both used in reference to shrubby range plants with a pungent odor. The sages referred to here belong to the sunflower family and are the most extensively found and abundant of the shrubs in the western United States.

Big sagebrush (*A. tridentata*) is an erect, branchy evergreen shrub 1½ to 15 feet tall. The grey-green leaves are ⅜ to ¾ inch long and are arranged alternately on the stems. They usually have three blunt teeth at the end, but may be deeply divided. The flower heads are in a dense panicle. Each head is very small and contains five to eight flowers enclosed by numerous bracts. The small seeds are produced in great number.

Big sagebrush covers a wide elevational range from 1,500 to 10,500 feet and grows largest and most abundantly on deep, alkaline-free soils. It often indicates productive sites for farming or seeding for range improvement. Big sage grows with other related species of sagebrush from which it is difficult to distinguish. A common species is black sagebrush (*A. arbuscula*), a much smaller shrub with the same essential value but found on more shallow or rocky sites.

Sagebrush can be an important winter browse for livestock, especially sheep. However, it is not very palatable. Crude protein in the foliage ranges from 8 to 13 percent year-round. Sage is a good source of feed for deer, antelope, grouse, Gambel quail, jack rabbit, and a variety of small mammals. On many winter deer ranges, the foliage and flowering parts are a staple in their diet. On some livestock ranges, sagebrush has increased because overgrazing has reduced grass density. Dense sagebrush further reduces grass yield, leading to extensive control programs. Big sagebrush does not produce sprouts following injury and may be killed by herbicides, burning, or plowing.





Big Sagebrush

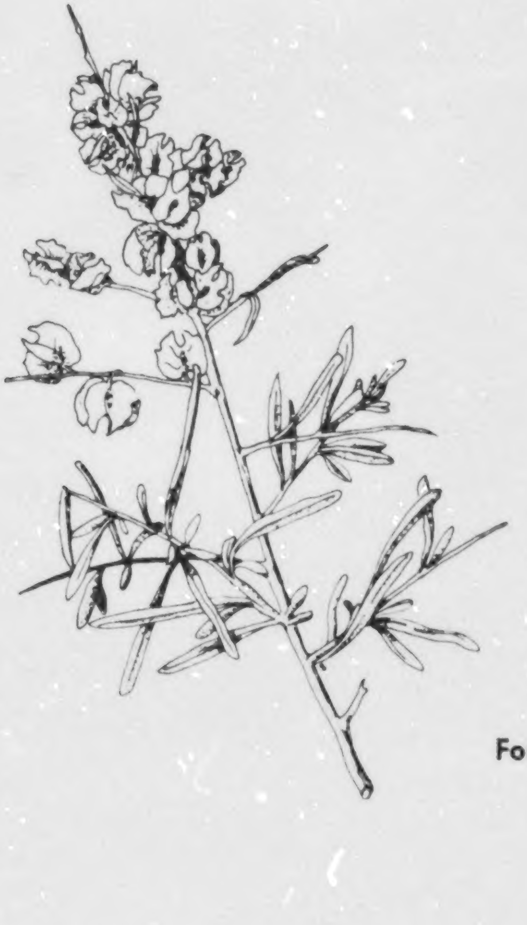
SALTBUSH

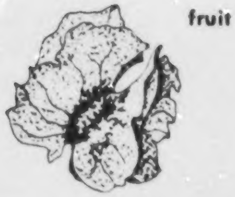
Atriplex spp.

Many species of saltbush are found in the West. Most common and important are spiny saltbush, or shadscale (*A. confertifolia*); and four-wing saltbush (*A. canescens*). These shrubby species are from 1 to 6 feet high and have mealy, rough, gray foliage. The alternate leaves are slender, rounded, and from 1/8 to 2 inches long. Male and female flowers appear on separate plants in early summer. Small seeds develop in the leaf axils, each enclosed within two round bracts. Shadscale is somewhat smaller than the others and is very spiny with two wing-like fruiting bracts. Four-wing saltbush is spineless and has four conspicuous wings on the seed bracts.

The saltbushes are common on alkaline and saline flats and basins below 7,000 feet in arid valley and desert areas mostly in the sagebrush, pinyon-juniper, and desert shrub regions. They are often associated with creosote bush and winterfat.

The saltbushes are all highly palatable browse species for sheep and cattle, especially in the late winter and early spring. All are important forage for deer and antelope on winter ranges. The protein content of spiny saltbush ranges from 6 to 9 percent. Saltbush may cause scours in cattle and poisoning of sheep. The fallen seeds and leaves are eaten in the autumn by livestock and deer. Although the spines of spiny saltbush protect the plant, heavy browsing has depleted stands in some areas. These shrubs provide valuable cover and feed for quail, rabbits, and a variety of small mammals and birds.





Fourwing Saltbush

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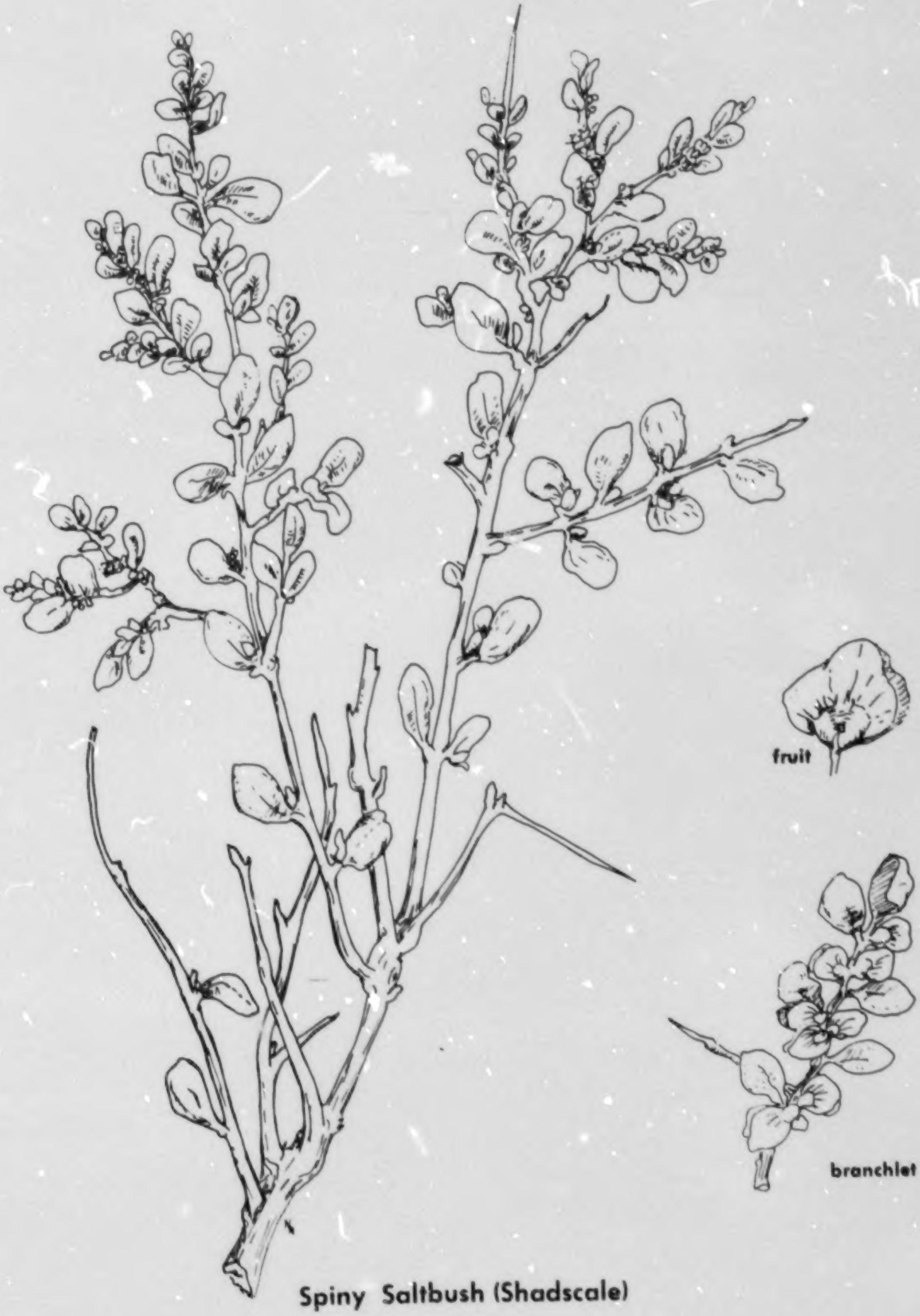

fruit
branchlet

Spiny Saltbush (Shadscale)

WILLOW

Salix spp.

Willows vary from shrub to tree in life form. Their deciduous, simple leaves are mostly narrow, smooth on the upper surface, and smooth or finely toothed on the margins. The leaves grow alternately on the branches and often have an ear-shaped lobe at their stem base. Individual plants bear either male or female catkins. The silky "pussy willow" is the young flower of the male plant.

The willows occur from sea level to over 10,000 feet elevation on a wide variety of soils. They inhabit only moist or wet sites where they may indicate potential for water development.

Willows sprout readily after browsing and are rated as fair forage for cattle and good for sheep and deer. Most browsing is in late summer near stock water and shady areas where groves are often highlined. Grouse often eat willow buds, and rabbits, elk, moose, beaver, and deer depend on the twigs, foliage, and bark as prime feed.

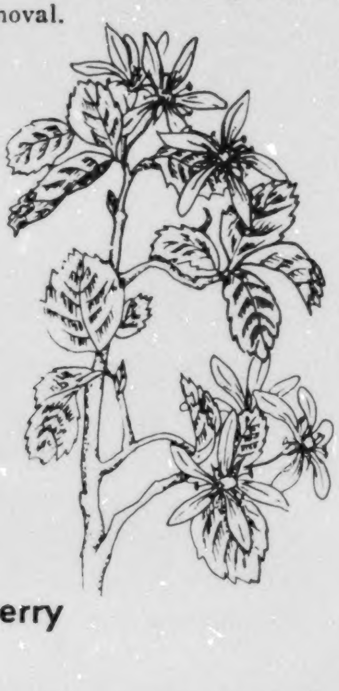
SERVICEBERRY

Amelanchier alnifolia spp.

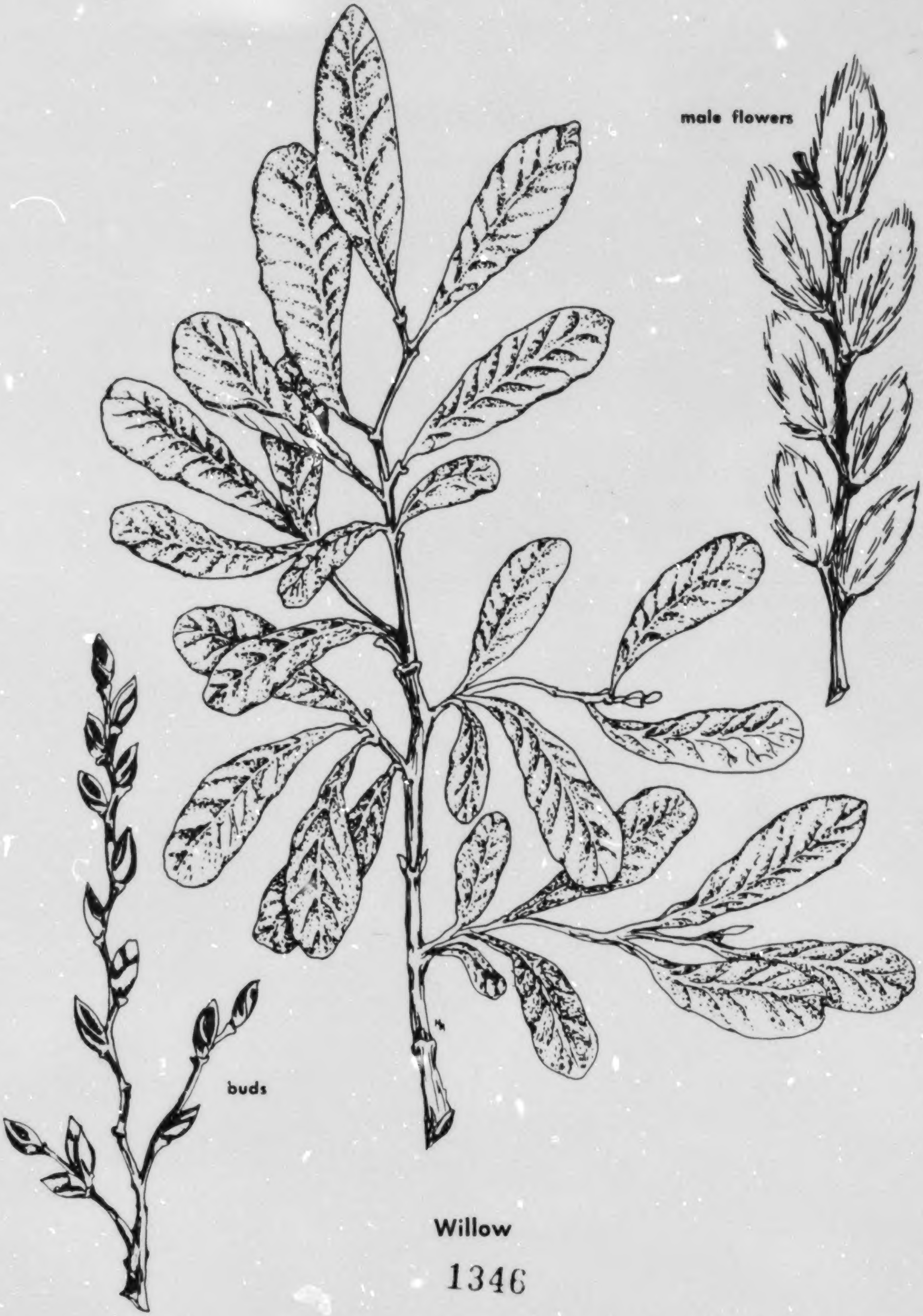
Western serviceberry is an erect shrub 3 to 15 feet in height with simple, alternate, deciduous leaves. The leaves are oval or rounded, from ¾ to 1¾ inches long and have margins sawtoothed above the middle. The white flowers have five petals, and are borne in clusters from April to June. Fruits are fleshy, purplish, about ¼ inch in diameter, and contain from 5 to 10 seed.

Serviceberry is widely found up to 11,000 feet scattered in the high mountains of the southern Sierra and Rocky Mountain ranges, north to the Canadian border and in the Coast Ranges at lower elevations. It is common in forest and chaparral types and adapted to a variety of moist sites.

This shrub is valuable browse to livestock and deer. The leaves and twigs contain as much as 14 percent protein during the summer when the plant is most browsed, and the berries are eaten by birds and mammals. The plant is quite resistant to close use and fire, sprouting soon after foliage removal.



Serviceberry


male flowers
buds

Willow

WINTERFAT

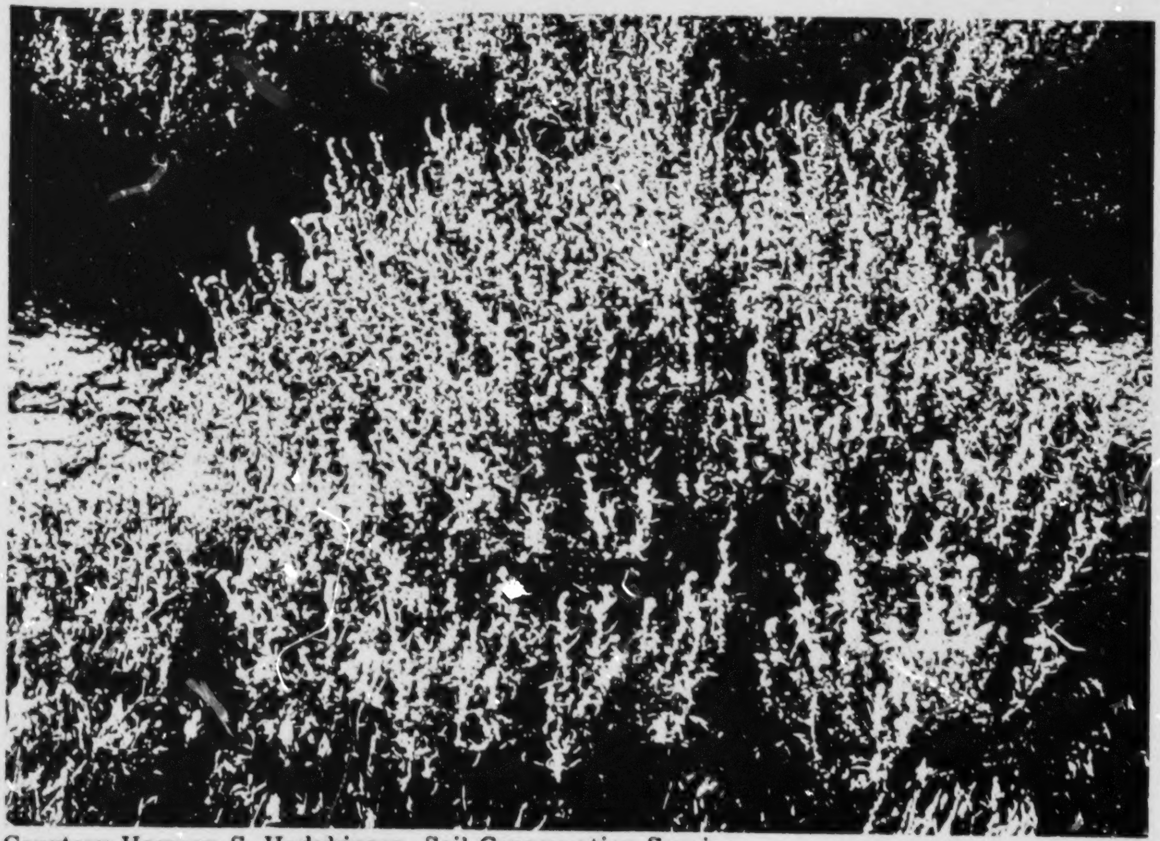
Eurotia lanata

Winterfat is a slender-branched shrub from 1 to 3 feet high, covered with white or rusty velvet. Leaves are narrow and from ½ to 1¾ inches long, with the edges curled. Clusters of late spring and summer flowers produce fruit with short horns and silky hairs. Winterfat is closely related to the saltbushes.

Winterfat is a shrub of the desert and grows on mesas and flats of alkaline soil, often saline in the deep rooting zone. It grows in pure stands in some areas but more commonly grows with saltbushes and other salt-tolerant desert shrubs.

Winterfat is highly palatable to sheep, cattle, horses and deer, and is considered a prime forage plant everywhere it grows. Seeds, leaves, and stems are browsed by these animals on fall and winter range. Crude protein ranges from 9 to over 12 percent during the grazing season and is much higher in the spring. The foliage has health-giving properties to livestock.

Even in average years, winterfat makes rapid growth and produces an abundance of viable seed when properly grazed. It has, however, been severely overgrazed on large areas. Because of its value on desert range, researchers are attempting to replenish stands of winterfat.



Courtesy Harmon S. Hodgkinson, Soil Conservation Service

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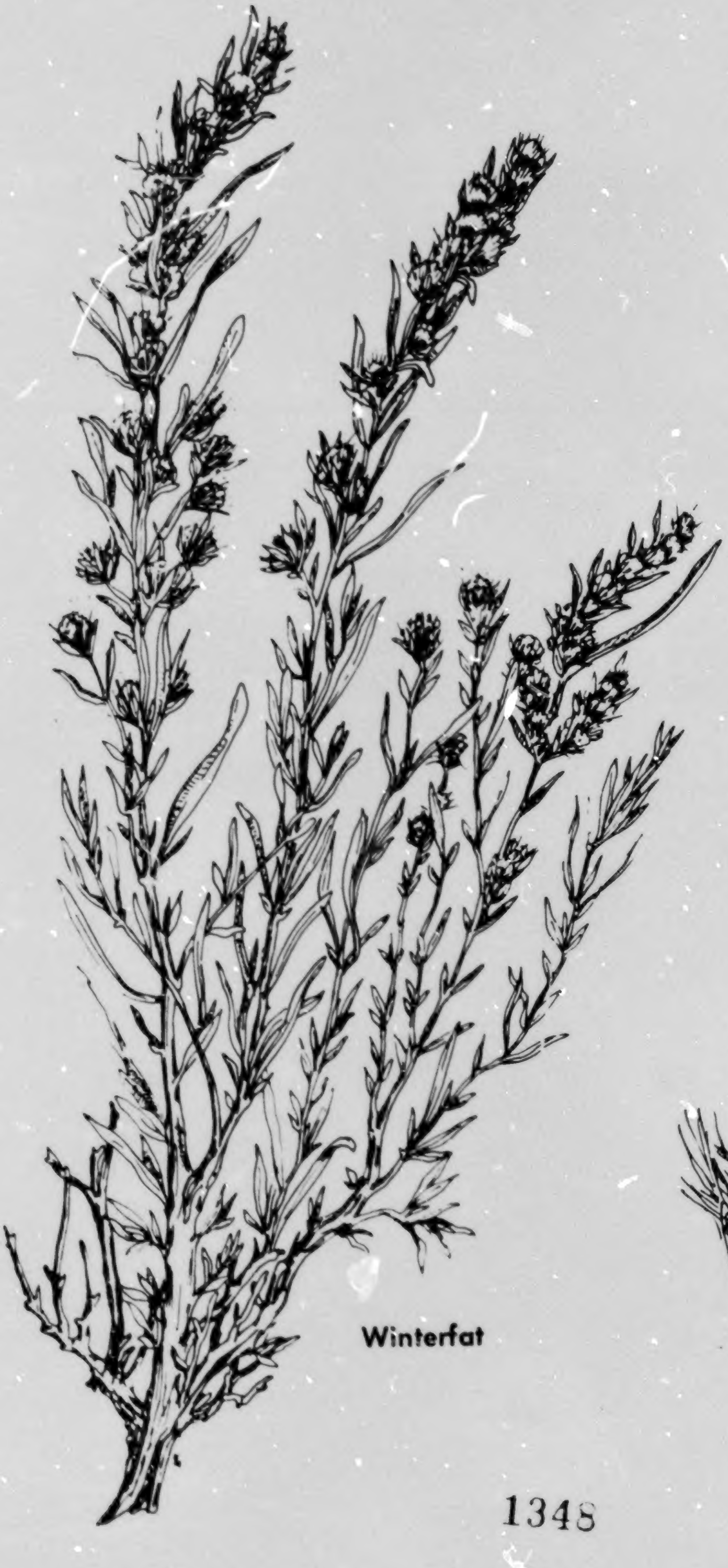
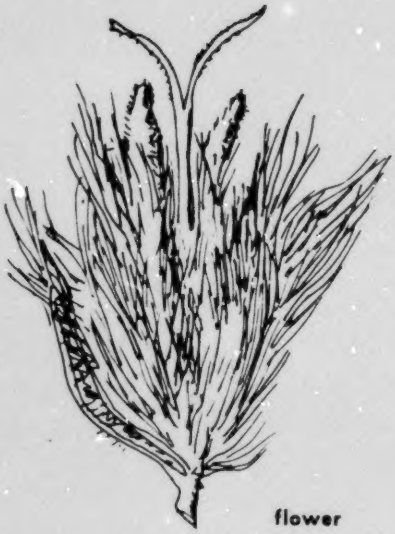


Winterfat



flower

HARVESTING EQUIPMENT

Five Weeks

Instructional Tips:

1. It is suggested that the five week harvesting equipment unit be spent on those pieces of equipment which are most commonly used in your local area.
    a. This may mean that the entire five weeks be spent on combines.
    b. Or, it may mean the mowers, rakes, and bales receive attention.
    c. It does not mean that you should teach combines, mowers, swathers, balers, forage harvester and other specialty equipment all in five weeks.
2. If you select Combines, purchase the FMO Instructor kit and student text "Combine Harvesting".
3. If you select Mowers, Balers, and/or other types of specialty for equipment, purchase the FMO Instructor kit and student text "Hay and Forage Harvesting".
4. Address for purchase of FMO materials:

John Deere Service Publications
Department F
John Deere Road
Moline, Illinois 61265

    a. Combine Harvesting Instructor Kit costs $21.55 (1983-1984), Student text is $8.28 each for 10 or more and $10.35 when ordering less than 10.
    b. Hay and Forage Harvesting Instructor Kit costs $25.75 (1983-1984), Student text is $10.52 each for 10 or more and $13.15 when ordering less than 10.

Combine Harvesting Objectives:

Upon completion of this unit the student will be able to:

1. Define what a combine is and does.
2. Identify common types of combines.
3. Identify the various parts of a combine and their function.
4. Know the various operating controls and their function.
5. Make appropriate field adjustments.
6. Know safe operating procedures.
7. Determine grain losses.
8. Trouble shoot field problems.
9. Perform required maintenance.
10. Know correct storage procedures.

Teaching Tips:

1. Complete Chapters 1, 2 , 4, 5 and 6 of the text.
2. Select appropriate lab exercises and teaching demonstrations from the instructors kit.
3. Have combines available for activities during the study of Chapters 4, 5, and 6.

Hay and Forage Harvesting Objectives:

Upon completion of this unit the student will be able to:

1. Appreciate the improvements in forage handling equipment made in recent years.
2. Mount, adjust, operate safely, and repair a mower.
3. Trouble shoot, perform maintenance on, and store a mower.
4. Mount , adjust, operate safely, and repair a hay conditioner.
5. Trouble shoot, perform maintenance on, and store a hay conditioner.

6. Adjust, operate safely, and transport a windrower conditioner.
7. Trouble shoot, perform maintenance on, and store a windrower conditioner.
8. Know baler types, operation and adjustment procedures, and safety regulations.
9. Trouble shoot, perform maintenance on, and store a baler.
10. Know types of specialty forage harvesting and handling equipment.
11. Understand advantages and disadvantages of each of above.
12. Know how to safely operate, adjust, maintain, trouble shoot, and store specialty types of forage harvesting equipment.
13. Calculate forage harvesting machine capacity and labor requirements.
14. Understand various harvesting system advantages disadvantages.
15. Select machinery appropriate to the job requirements.

Teaching Tips:

1. Complete Chapters 1, 2, 3, and 4.
2. Select Chapters appropriate to your region from 5 - 14.
3. Select appropriate lab exercises and teaching demonstrations from the instructors kit.
4. Have machinery available for lab activities.

Bee Production

Instructor's Guide:

1. This unit was developed to provide information related to Bee Production.
2. Field trips and guest speakers are valuable resource tools.
3. Utilize the County Extension Agent for resource information.
4. Identify those students who may have an allergic reaction to Bees. They should not participate on field trips or be exposed to Bees.

Objectives:

Upon completion of this unit, the student will be able to:

1. Discuss when, where and how to begin a Bee colony.
2. Identify beekeeping equipment.
3. Describe and understand the Honey Bee colony.
4. Identify the source of Bee pastures.
5. Understand the Honey Bee and pollination process.
6. Identify the causes, signs and prevention of swarming.
7. Discuss the honeyflow and removal of the crop.
8. List the uses of honey and beeswax.
9. Discuss the fall management and wintering of Bees.
10. Discuss the spring management of the overwintered colony.
11. Identify the diseases of Bees.
12. Discuss Queen management.

Teaching Aids:

1. Leaflets, Booklets and Circulars: U.S. Department of Agriculture
   OSU Extension Service
2. Sound Film Strips available on Bee production.
3. An active Honey Bee Colony.
4. Examples of Beekeeping equipment.

Student Activities:

1. Read the objectives in this unit.
2. Arrange a section in Vo-Ag notebooks on Bee Production.
3. Assign students who have an interest in, know about or have neighbors with Bees to give an oral report or to help arrange a field trip.
4. Allow students to work with Bees if possible.

References:

1. First lessons in Beekeeping: C.P. Dadant
   Dadant Publications
2. Selecting and Operating Beekeeping Equipment:
   Farmers' Bulletin #2204
   U.S. Department of Agriculture
3. Shade and Water for the Honey Bee Colony: Leaflet #530
   U.S. Department of Agriculture
4. Using Honey Bees to Pollinate Crops: Leaflet #549
   U.S. Department of Agriculture
5. Removing Bees from Buildings: Extension Circular #857
   OSU Extension Service

Introduction Ideas:

1. Sound Film Strip: "The Business of Bees"
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407
   1982 Cost = $32.50

Appendices:

1. Appendix A: Honey Bee Diseases and Their Control:
   P.N.W. #198
   OSU Extension Service

2. Appendix B: Oregon Administrative Rules: U.S. Department of Agriculture

I. Bee Production

A. When, Where and How to Start with Bees

1. Bees can be found in a variety of locations

   a. The city
   b. The suburb
   c. On a small farm
   d. Large acreage

2. Bees can be kept in nearly every area and condition except in:

   a. Extreme heat
   b. Extreme cold
   c. Minimum standards of vegetation

3. The best time to start a bee colony

   a. In the spring around fruit blooming time

      1) May be a fully established colony
      2) May be new equipment and packaged bees

   b. The first season is the learning season

      1) Learning how to manipulate the equipment
      2) How to handle bees
      3) How to diagnose and solve the problems of bees
      4) The bees establish their own colony

4. The best location for the bee colony

   a. No particular location is necessary
   b. Bees have a flight range over 12 square miles
   c. Rules of thumb

      1) Raise beehive a few inches above ground on blocks to avoid dampness
      2) Good windbreak on north or west in form of fence or shrubbery
      3) Hives should face with entrances away from prevailing winds
      4) A south or east exposure is good

5. How to begin the bee colony

   a. Purchasing a full colony of bees in good condition from a neighboring established beekeeper
   b. Secure box hives or bee tree logs and do transferring into the modern movable frame hives

c. Purchase bee hives and equipment from a bee supply firm; prepare beehive equipment and import packages of bees
d. Advantages and disadvantages of establishing methods

   1) Purchasing a full colony

      a) Advantages

         1.1) Bees are already established
         2.2) Good resource has been established

      b) Disadvantages

         1.1) Failure of an old queen
         2.2) Bee diseases

   2) Box hives or tree logs

      a) Advantages

         1.1) None

      b) Disadvantages

         1.1) Vigor of stock may be poor
         2.2) Disease problems
         3.3) Transferring may be difficult

   3) Acquiring bees and equipment from supply company

      a) Advantages

         1.1) Most efficient way to get started
         2.2) Young queen bee
         3.3) Diseases eliminated

      b) Disadvantages

         1.1) None

e. Races of bees

   1) Italian

      a) Generally accepted as the standard in America
      b) Carniolan
      c) Caucasian

B. Beekeeping Equipment

1. The Hive

   a. A good hive is necessary
   b. Gives beekeeper complete control of the combs, the mainstay of the business
   c. Large hive

      1) To avoid overcrowding
      2) Minimize swarming
      3) Accomodate a prolific queen and brood
      4) Enough room to live, work, raise brood and store pollen and honey

   d. Components of the hive

      1) Hive stand

         a) Has an angled landing strip
         b) Built for bees returning loaded with honey or pollen

      2) Bottom Board

         a) Serves as the floor of the hive
         b) Has various means of reducing or enlarging the entrance to the hive

      3) Hive Body

         a) Resting on the bottom board is the brood chamber
         b) Queen bee lays eggs
         c) Baby bees are raised
         d) Two brood chambers are recommended

      4) Queen Excluder

         a) Looks more like a grill
         b) The grill work prevents the queen bee from passing into the supers, but allows working bees passage of either direction

      5) Supers

         a) Purpose is for extracting honey
         b) Come in a variety of depths

      6) Inner cover
      7) Bee escape
      8) Telescoping cover

2. Frames
   a. Self-spacing frames are in general use
   b. Spacing for frames containing combs are from 1 3/8" to 1 1/2" from center to center within the brood chamber
      1) Too close or too wide placement results in imperfect combs
      2) Creates undesirable irregularities

3. Beekeeper's Equipment
   a. Clothing
      1) Light-colored clothing
      2) Cotton type material
      3) Lightweight helmet
      4) Gloves
      5) Bee veil
   b. Bee smoker
      1) One of the most important tools
      2) Works to subdue the bees because it frightens them and they rush to gorge themselves with honey preparatory of flight
   c. Hive tool
      1) All-purpose tool used for pulling nails, taking off cover and inner cover
      2) Required for separating the different stories of the hive and prying frames apart
   d. Bee brush
      1) Has long fiber or soft plastic bristles
      2) Ideal for removing bees from clothing, hive parts and frames of brood or honey

4. Miscellaneous Equipment
   a. Entrance feeder
      1) Standard screw-on lid with perforations that fit any size mason glass jar
      2) Jar is filled with syrup and is inverted over a holder
      3) Fits into the hive entrance

- b. Division board feeders
    - 1) Plastic container resembling a frame
    - 2) Filled with syrup
    - 3) Hung in the hive
- c. Spur embedder
    - 1) Used to embed the horizontal wires into foundation to add to its strength

5. Honey Handling Equipment

- a. Depends upon the type of production desired
    - 1) Produce honey in one pound boxes called sectins
    - 2) Produce honey in shallow frames for own use
    - 3) Produce liquid or extracted honey

C. The Honey Bee Colony

1. The honey bee colony make-up

- a. The worker
- b. The queen
- c. The drone

2. The queen

- a. The only perfect female in the colony
- b. The true mother of the colony
- c. Queen bee's duty is to lay the eggs for propagation
- d. The queen is larger in size than the worker but not as large as the drone
- e. The queen has a sting but it is curved and only used to fight or destroy rival queens
- f. The queen bee at 5 or 6 days
    - 1) Takes flight to mate with drones
    - 2) After being fertilized, she remains so for life
    - 3) Continues to live for 3 or 4 years
    - 4) A few days after mating she commences to lay eggs
    - 5) Capable of laying as many as 3000 eggs a day
    - 6) The eggs are deposited by the queen in the cells within the brood chamber
    - 7) Eggs are usually laid from January to November
    - 8) Eggs are laid most rapidly when fruit and flowers are in bloom

3. The Drones
   a. Drones are shorter, thicker and bulkier than the queen and their wings reach the entire length of the abdomen
   b. They are the males and have no sting
   c. They do not gather honey or secrete wax
   d. Only purpose is to mate with the queen bee and upon doing so they die
   e. After the swarming season or an unfavorable crop, the drones are destroyed by the workers

4. The Workers
   a. The underdeveloped females and they do all the work that is done in the hive
   b. The workers duties include
      1) Secreting wax
      2) Build the comb
      3) Ventilate the hive
      4) Gather pollen for the young and honey for all
      5) Feed and rear the brood
      6) Fight all the battles to defend the colony

5. The Development of the Brood
   a. The brood is the eggs and young of the bee
   b. The brood is found in the combs of the brood nest or body of the hive
   c. The three different kinds of brood
      1) The queen cell, when empty, looks like an acorn cup and when sealed like a peanut
      2) The sealed worker brood differs from sealed honey in its uniformity and in the leathery appearance
      3) The drone brood differs from the worker brood in its roundish cappings which look like bullets

D. The source of bee pasture

1. The profit of beekeeping depends on
   a. The plants within flying range
   b. Blooming time
   c. Quality of honey which they yield
   d. Acreage within reach

2. Important pollen plants

    a. Pollen

        1) Provides the protein for the growing larvae
        2) It is consumed in large quantity
        3) Without an abundant supply of pollen there can never be a profitable commercial honey production

    b. Yielding plants

        1) Maples are among the first to yield either nectar or pollen
        2) Native elm trees bloom very early and yield a great abundance of pollen
        3) As spring advances a wider variety of plants come into bloom and nectar and pollen are more readily available

    c. How weather affects pollen collection

        1) Cold and rainy weather confines the bees to the hives when the nectar harvest is on
        2) At this time the fruit trees and dandelions offer an abundance of forage and when weather is favorable, surplus honey is stored

3. Sources of surplus

    a. There are only a few plants which yield surplus honey in large quantity that are widely grown
    b. There is a larger number of plants which provide good crops in limited areas but honey from these sources are not commonly found on the market
    c. Sources

        1) Sweet clover

            a) Source of a more marketable honey than any other crop
            b) Honey is very light in color
            c) Honey is mild in flavor

        2) Alfalfa

            a) Source of large quantities of white honey
            b) Honey is darker in color
            c) Honey is more highly flavored

E. The honey bee and pollination

1. The pollination process

   a. A large number of plants are fruitful only when pollen from the flowers of one plant is brought to the flowers of another to insure fertilization
   b. In some cases unprofitable crops will result from lack of pollination when growing conditions were favorable
   c. The honey bee is the most efficient means of pollen distribution

2. The honey bee

   a. Bees show a preference for flowers with nectar of the highest sugar content
   b. Bees are constant to one kind of flower while it is in bloom and visit only that species while its flowers are open
   c. Make sure there are enough honey bees in the neighborhood to insure visits to the flowers with low sugar content to avoid non-pollinated crops

3. Factors involved to insure crop pollination

   a. Acreage within flying range
   b. Length of the flowering period of the plants to be visited
   c. The number of honey bees in the neighborhood
   d. The weather at flowering time
   e. Good rule of thumb is to bring in more bees than thought necessary

F. The causes, signs and prevention of swarming

1. Purpose of swarming

   a. One of nature's ways of dividing colonies to create new ones
   b. In the wild swarming propagates the species
   c. In man-made environment, swarming is often a symptom of problems within the hive

      1) Overcrowding
      2) Improper ventilation
      3) Starvation

   d. Swarming usually takes place in May or June

2. Causes of swarming
    a. Improper conditions within the hive
        1) Overcrowding
        2) Improper ventilation
        3) Impulses
    b. Bees natural instincts
        1) Use swarming to overcome improper conditions within the hive
        2) Swarming usually takes place in May or June
            a) First swarm occurs almost anytime from the hours of 10:00 a.m. to 3:00 p.m.
            b) The second and third swarms from 7:00 a.m. until 4:00 p.m.
3. The signs of swarming
    a. The bees may be seen clustering at the entrance of the hive
    b. The brood nest is out of free space, its cells are either full of sealed brood, honey or pollen
    c. Construction of a burr comb--irregular bits of comb constructed in any available space
4. Prevention of swarming
    a. Keep the brood nest as free as possible at all times
    b. Keep plenty of worker combs containing empty cells for egg laying and with a minimum of honey and pollen in them
    c. Add more empty combs at the sides of the brood combs so the queen bee may use them
    d. Expand brood nest by supplying another brood chamber
    e. Add supers for storage of nectar and honey
    f. Increase the entrance to the hive to allow more ventilation
    g. Maintain a good, healthy, productive queen bee

G. The honeyflow and removal of the crop

1. The process
    a. Bees gather nectar and subject it to a chemical process which results in unripe honey
    b. The unripe honey is stored in cells

   c. Later the unripe honey is capped
   d. A frame of honey consists of thousands of capped cells, constructed side by side, back to back
   e. Extracted honey is the liquid honey removed from the comb
   f. The comb is then returned to the bees for refilling

2. Comb honey

   a. Is marketed in the comb which is consumed as part of the product
   b. Comb honey is produced in two forms

      1) Section comb honey
      2) Bulk comb honey which is later processed into chunk honey or cut into comb honey

3. Bulk comb honey

   a. Produced in shallow supers
   b. The frames are filled with a high quality of thin surplus or bulk comb foundation that is made especially for that purpose
   c. The slabs of bulk comb honey weigh from 3½ to 4 lbs.
   d. The first bulk comb honey super should be put on as soon as the main honeyflow has started
   e. The second super is placed on top when the first one is half full
   f. Additional supers are added
   g. The supers are removed as soon as they are capped

4. Chunk honey

   a. The bulk comb honey is cut into rectangles which fit into the mouth of a glass jar
   b. Remaining space is filled with liquid honey which has been heated to 150°F, then cooled to room temperature
   c. Do not store for too long a time since it will be apt to granulate

5. Cut comb honey

   a. Bulk comb honey cut up into varying sizes or pieces

      1) As small as 2 ounces
      2) As large as one pound

   b. The cut pieces of comb honey are drained on a screen in a warm room for 24 hours
   c. The well-drained sections may be placed in specially-designed plastic cut comb boxes
   d. The finished product resembles section comb honey

6. Robbing
    a. During any period of the year when there is no nectar coming into the hives the bees are apt to rob
    b. A strong colony will attempt to get into another which is weak in numbers and obtain the honey
    c. Death usually results in the colony that has been robbed
    d. Robbing usually occurs shortly after the honeyflow is over
    e. Cloths dipped in a mixture of water and kerosene and wrung out are used to cover the hives

H. Honey and beeswax

1. Principal products of the honey bee colony
    a. Honey
    b. Beeswax

2. Honey
    a. The honey bee visits the flowers which secrete a sweet liquid called nectar
    b. The nectar is sipped from the blossoms by the bee and carried to the beehive in the bee's honey stomach
    c. Some enzymes may be added on the trip to the hive as well as some thickening may take place but the raw nectar goes into the cells in almost the same condition as taken from the flower
    d. In the hive, the house bees evaporate the nectar down to a thick consistency which is today's commercial honey

3. Uses of honey
    a. A table spread for bread, biscuits or pancakes
    b. Used in cooking and baking
    c. Used in canning
    d. Used in milk drinks
    e. Used in syrups and desserts

4. Beeswax
    a. The second most important product of the beehive
    b. Produced by the honey bees themselves in the hive
    c. It is extruded between the segments of the underside of the abdomen of the bee while she is gorged with honey

5. Why beeswax is formed
    - a. Formed into comb for the bee's brood
    - b. Combs for surplus honey
    - c. Sealing the combs when they have been filled with honey

6. Uses for beeswax
    - a. Candles for lighting
    - b. Cosmetic industry
    - c. The beekeeper himself--using beeswax in the form of comb foundation

I. The fall management and wintering of bees

1. Nectar flow schedule
    - a. Midseason flow ends and nectar gathering ends
    - b. A period of little or no nectar coming into the colony
    - c. The fall flow begins in many areas and nectar usually comes from flowers such as smartweed, aster, goldenrod, wild cucumber and climbing milkweed

2. The fall flow
    - a. The fall flow is greatly influenced by the queen bee
    - b. An inferior queen
        - 1) Will lead to a colony that is weak in worker population
        - 2) Will lead to a colony incapable of wintering successfully
        - 3) If slightest indication of a poor queen, the colony should be requeened during the fall flow
    - c. Areas which have little or no fall flow
        - 1) Colonies may be safely requeened after cold weather has set in
        - 2) Colonies may be requeened after brood rearing has ceased

3. Care of the supers
    - a. During the fall flow do not place too many supers on the colony
    - b. Additional supers are added only when one in the colony is practically full of honey

   c. This prevents the bees from spreading the incoming nectar throughout more supers than they will fill
   d. After the fall flow--usually after the first killing frost--the supers are removed from the hives
   d. During the removal of the crop, one super completely filled with honey should be left in the colony

4. Uniting weak colonies

   a. Reasons for weak colonies

      1) Caused by a failing queen
      2) Bad season with a minimum of honey to be gathered

   b. Corrections for weak colonies

      1) Supply new queens
      2) Ample feed provided
      3) Best situation is to put strength of two weak colonies into one hive to unite and survive the winter

5. Packing the hives

   a. Packing hives with heavy coating of straw, leaves or other insulating material
   b. Problems arise when warm days during the winter occur and the bees are forced to move outside
   c. Today the trend is to not pack the hives for winter insulation and the bees winter just fine
   d. The bottom and top entrances must be reduced whether the hives are packed or not
   e. A windbreak would be helpful for winter protection

6. Review for successful wintering

   a. A good queen early in the fall
   b. Plenty of young bees
   c. A minimum of 50 pounds of stores--honey, sugar syrup or both
   d. Reduced lower entrance and a one inch auger hole in super
   e. Protection from prevailing winter winds
   f. Exposure to winter sunshine

J. Spring management of the over-wintered colony

1. Spring management

   a. Remove the packing and dispose of it
   b. Tilt the hive back

c. Remove the bottom board and scrape it clean of debris or dead bees
d. Replace the hive on the bottom board
e. Replace entrance reducer

2. Spring examination

   a. Evidence of a laying queen
   b. Supply of honey and pollen stores
   c. If a laying queen is present, the brood rearing will start early--February or March
   d. A strong colony but, no queen, order a new queen immediately
   e. If the colony is short on food, no sealed honey in the combs, then feed the colony sugar syrup

      1) Sugar syrup (1 part sugar to 1 part hot water)
      2) Allow to cool before using
      3) Continue feeding until natural supply of nectar is sufficient

   f. Check for pollen reserves

      1) If low supply with a pollen substitute
      2) 1 part animal type brewer's yeast and 2 parts of expeller--processed soybean flour by weight
      3) Add sugar syrup to pollen mixture until paste-like consistency
      4) Spread on top of the frames directly above where bees are clustered and cover with wax paper
      5) Add Terramycin to each pollen substitute cake and each feeding of syrup during the spring period

3. Mid-spring management

   a. The period of great increase in colony strength

      1) The beginning of apricot and pear blossoms
      2) The last of the apple blossoms

   b. Queen's egg laying

      1) Full combs of solid brood
      2) Watch for spotty or small amount of egg laying

   c. Strong queen but weak worker population

      1) Exchange an empty comb from weak colony with a good comb of emerging brood
      2) Exchange bees from a strong colony that can spare the loss of a few bees

      3) Be sure not to remove the queen bee
      4) Place combs on the side of hive so the strange bees will not kill the queen bee

   d. Switching

      1) Worker bees leave the hive to collect nectar
      2) Worker bees return by habit to the usual location of their hive
      3) Replace worker bees hive with a weaker worker population
      4) Strong worker bees return to weaker colony and thus build up worker population

4. Late spring management

   a. From fruit blooming until blooming of dandelion and clover there may be a lull where little or no nectar is gathered
   b. Syrup may need to be supplied at this time
   c. This period is a danger period

      1) Avoid starvation
      2) Avoid swarming

K. Bee diseases and enemies
(Refer to Appendix)

L. Queen management

1. Purchasing bees

   a. Buy bees which have been carefully bred
   b. Possible to breed desirable characteristics for honey production

      1) Hardiness to withstand the rigors of the climate
      2) Hardiness to withstand bee diseases and enemies
      3) Should be gentle in order so they may be handled with maximum speed and efficiency
      4) Should remain quiet on the comb
      5) Should give little trouble when being examined
      6) Should be industrious
      7) Should breed to strong colonies for the honeyflow
      8) Should be out early and late for nectar, pollen and water

2. Requeening

   a. The future of the colony of bees depends solely on the queen
   b. Requeening means changing the queen of a colony

   - 1) To secure better stock
   - 2) Replace a queen who has passed her peak

- c. Colonies will replace their queens naturally but it takes longer than beekeepers desire
- d. Usually requeen during a light honeyflow
- e. Beekeeper must use own judgment as to how often to replace queen
- f. To introduce a new queen successfully, find the old queen and dispose of her

3. Queen management

- a. Queen's wing may be clipped to prevent her from leaving with a swarm
   - 1) Wing must not be clipped before mating with a drone
   - 2) Otherwise will remain infertile

Appendix A

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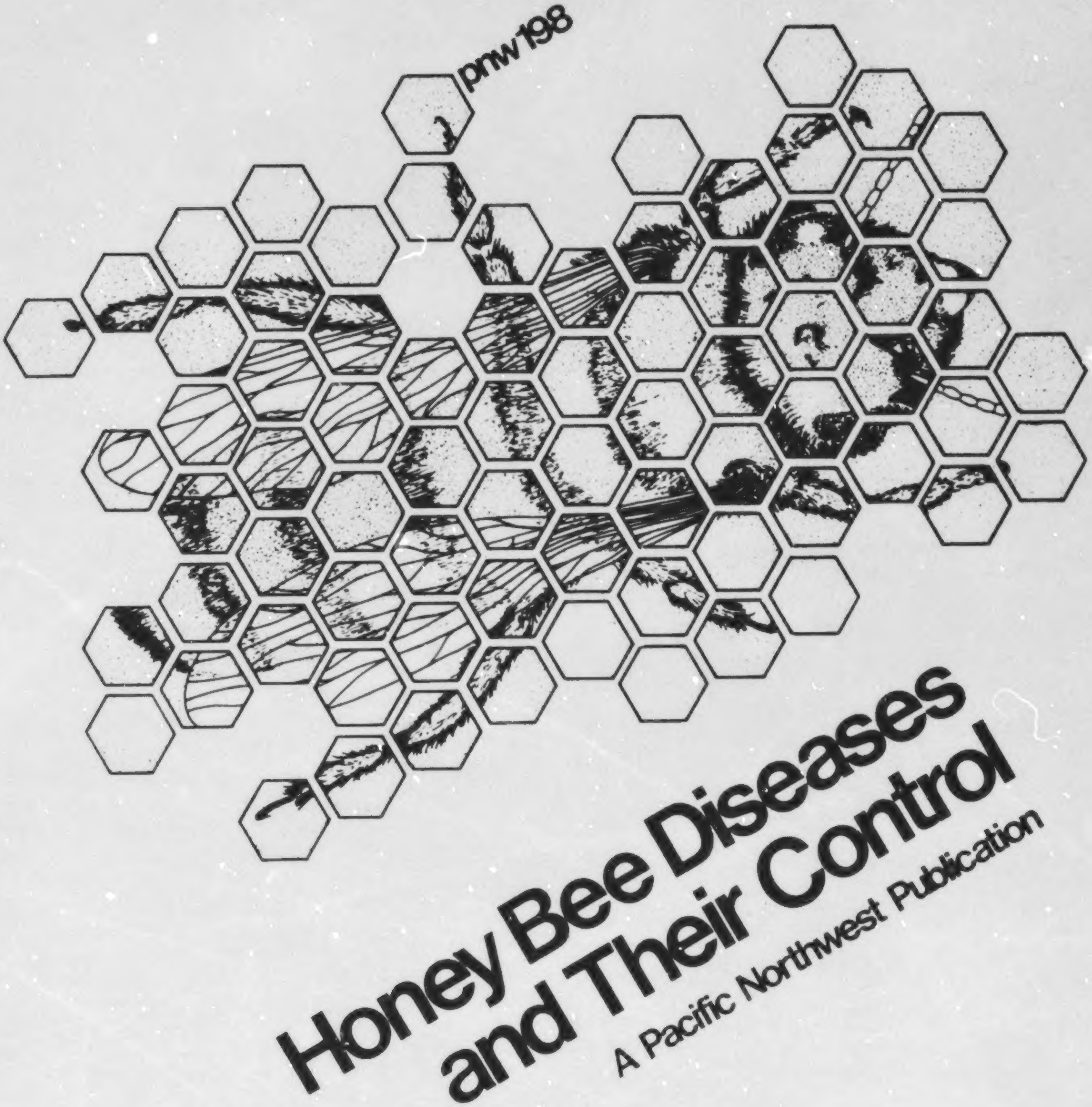

Honey Bee Diseases and Their Control

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Honey Bee Diseases and Their Control

by *Carl Johansen*, Dept. of Entomology, Washington State University, and *Michael Burgett*, Dept. of Entomology, Oregon State University.

Presence of a bee disease in an apiary can mean the difference between a good honey yield or none at all. It is imperative that all beekeepers be able to recognize the symptoms of the principal bee diseases soon after they appear so that adequate precautionary measures can be taken to prevent their further spread. Good disease control is best accomplished by preventive measures that do not allow the start of bee diseases in your colonies.

DISEASES OF ADULT HONEY BEES

The most threatening of all bee diseases are those which attack the brood (larvae and pupae). However, beekeepers must also guard against diseases which attack adult bees. Two of the most common diseases are Nosema and paralysis.

Nosema

Nosema is the most widespread of all adult bee diseases, especially under northern climatic conditions where bees are confined for long periods of time without flight during the winter and early spring. The disease varies with the season, worsening in the late winter and spring. Nosema symptoms normally disappear with the onset of warmer weather in the later spring and summer.

Nosema is caused by a protozoan called *Nosema apis*. This parasitic microorganism is transmitted among adult bees as a spore which enters the midgut of the adult where it attacks the cells which line the wall of the intestine. Spores can be transmitted in food and water. It is known that the spores can be passed out with the faeces of bees, and combs are often contaminated in this manner.

Symptoms. Worker bees can be seen wandering about the entrance of the hive or in the grass near the hive. The abdomen of an infected bee is often distended and shiny in appearance. Many of the affected bees will have their wings spread at an abnormal angle, and are unable to fly.

Control. Fumagillin, an antibiotic drug, is a control material for Nosema disease. It is the most practical method for commercial beekeepers who must manipulate hundreds or even thousands of colonies. One level teaspoon of Fumidil-B (a commercial preparation of fumagillin) dissolved in 2 gallons of a 1-to-1 sugar syrup will treat two colonies. Fumidil-B can be obtained only through bee supply companies.

To prepare a medicated syrup, heat the water to about 160°F; remove from heat. Add the sugar and stir until the mixture becomes a clear syrup. Finally, dissolve the Fumidil-B in a small amount of warm water and mix it into the syrup. Feed the medicated syrup to the colonies in the fall or both in the fall and spring, *but never during or immediately before a honey flow.* Feeding during both spring and fall provides maximum effectiveness.

Fumidil-B can also be added to pollen supplements. The dosage in the syrup to be added to the supplement should be about double that given in the directions above. A basic recipe for pollen supplement is as follows:

3 pounds brewer's yeast
3 pounds sucrose
2½ pounds (approximately 2½ pints) hot water

If you wish to use pollen in the mixture, add 10% by weight of clean pollen. It may be necessary to add more water if pollen is used, but only use enough water to form a doughlike consistency. Less than the amount in the recipe may be sufficient in humid areas.

To prepare supplement cakes, first mix the pollen into the hot water. When the pollen has softened, add the sugar until dissolved or in smooth suspension. Finally, add the brewer's yeast and mix by hand, adding until the supplement has the texture of a doughlike paste (neither runny nor hard). Portion into 1½-pound cakes and flatten to ½ inch. Place these on the top bars of the frames directly over the brood cluster.

Paralysis

There are several conditions that cause symptoms similar to paralysis in adult bees. Paralysis is caused by

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The manuscript was reviewed by P. F. Thurber, Kirkland, WA; James C. Bach, Chief Apiary Inspector, Div. of Plant Industry, WSDA, Yakima, WA; and Robert Saunders, State Entomologist, ISDA, Boise, ID.

a filterable virus. There are several forms of paralysis each differing only slightly in the observed symptoms.

Symptoms. The adult bees are often dark colored and shiny. The bees tremble and become weak and unable to fly. The affected bees usually crawl out of the hive to die or are carried out by healthy adults. Paralysis, like Nosema, usually is most severe in the late spring and disappears by early summer. It is what is often termed a "stress" disease and an infected colony is rarely destroyed by paralysis.

Control. There are no known chemical control materials available for the treatment of paralysis. If the disorder persists, the colony should be requeened.

One method of relieving paralysis is to move an infected colony 50 to 100 feet from its original location. All the worker bees should be shaken on the ground and the brood, queen, and remaining frames placed back into the hive at its original location. This should be done on a warm, sunny day. Most of the foragers will return to the original location, but most of the adult house bees with paralysis will be too weak to do so. The diseased bees should be killed within a few days. This treatment is not recommended unless the colony is fairly strong and populous because it sacrifices most of the healthy, young house bees.

Dysentery

While this is not a disease in the pathological sense, it too is often encountered in the spring.

Symptoms. Dysentery is the accumulation and release of faeces inside the hive. Dysentery is usually a sign of poor-quality winter stores, of moisture leakage into the hive, or inadequate protection.

Control. Bees wintered out-of-doors with supplies of good quality will normally take flight on warm, sunny winter days. In such hives dysentery does not appear.

DISEASES OF THE BROOD

American foulbrood (AFB) is by far the most serious of the diseases that attack the immature stages of honey bees (brood). Next in importance is European foulbrood (EFB); then chalkbrood, and finally, sacbrood. Occasionally a condition known as "chilled brood" appears in a colony. It occurs when the temperature in the brood nest lowers enough to kill a quantity of brood. In chilled brood it is usually the brood along the outer margins of the brood comb that is killed, while the brood area near the center remains healthy. Diseased larvae and pupae, by contrast, are found scattered among healthy larvae throughout the brood area. See brood disease identification chart on page 4.

American foulbrood

American foulbrood is considered the most serious and destructive of all bee diseases in the United States. A colony can very quickly succumb to this disease. It is caused by a spore-forming bacterium, *Bacillus larvae*. Adult bees are not affected by this disease, but they can carry the infectious spores on their bodies or in their honey stomachs.

AFB is spread through the interchange of infected combs, or by bees robbing the honey stores of colonies weakened by the disease. Spores can live in honey and infected equipment for years. Once it begins AFB is extremely difficult to combat.

Symptoms. American foulbrood kills the infected brood while they are older larvae or pupae, but primarily in the sealed stage. The larvae dry down to the bottom of the cell and turn a coffee color. The decaying larvae have a ropy consistency and can often be pulled out of the cell ⅝ inch or more with the head of a match (see fig. 1). They usually have a foul, rotten odor. Scales formed by the dead larvae or pupae stick tightly to the bottoms of the brood cells. It is very difficult for house bees to remove these scales. This is one reason why AFB is so difficult to completely eradicate from hives.

AFB characteristically kills the pupa, the intermediate stage between the larva and the adult bee. The pupa decays in the same manner as the larva, finally drying down to a black scale. The tongue of the pupa, like a fine thread, sometimes points toward the top of the cell. This characteristic is unique to AFB. See figures 2 and 3, page 4.

Once the spores of AFB are ingested by a larval honey bee they enter the digestive tract where the spore changes to a vegetative rod form, multiplies rapidly, and attacks the wall of the alimentary canal. This will eventually kill the infected larva.

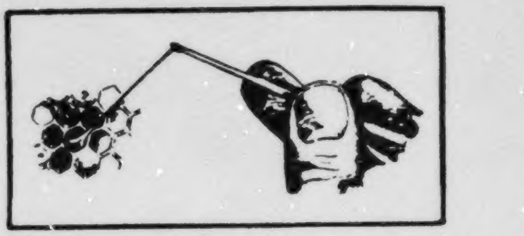


Figure 1. Diagram of a match test for the American foulbrood.

IDENTIFICATION OF BROOD DISEASES

	American foulbrood	European foulbrood	Sacbrood	Atypical European foulbrood
Causative organism	Bacillus larvae	Steptococcus pluton	Filterable virus	Bacillus alvei
Odor	Usually strong and foul	Slightly acid-sour	None to slightly sour	Slightly acid-sour
Amount of brood affected	Usually much	Usually much	Usually little	Usually much
Cappings	Often sunken and perforated	Affected brood mostly unsealed	Sunken caps less prominent than AFB, some with two holes	After sunken and perforated
Age of larvae	Usually die after capping	Usually die before capping	Usually die after capping	Many die after capping
Color of larvae	Become dark brown	Yellow, gray, brown	Become dark brown, head end darker	Become dark brown
Consistency of the larvae	Sticky, "roping" out ⅝" or more	Soft, breakable, sometimes slimy	Watery, graunlur, tough skin forms a sac	Slightly sticky rope. If any, less than ½"
Position of dead larvae in cells	Usually lengthwise. Soon become shapeless	Usually curled at bottom or on side-walls	Lengthwise, become mummified	Usually lengthwise soon become shapeless
Pupae	Sometimes affected. Tongue usually sticks up	Not affected	Rarely affected	Sometimes affected
Scales	Dark brown, stuck to floor of cell, brittle; fluoresce in ultraviolet light	Yellow to brown. Usually small, free, and at bottom of cell, tough and rubbery	Blackish, free, lengthwise along floor, brittle	Sometimes found but not stuck to floor of cell. Very hard. Can generally be removed

Control. Sulfathiozole, which was previously used as a preventive treatment for AFB, has been removed from this use by the Environmental Protection Agency. USDA researchers at Beltsville, Maryland are currently trying to obtain the data required for reinstatement of this medication. Directions for use of terramycin for prevention of both AFB and EFB are listed under the control section of the European foulbrood discussion.

Disposal. Bee inspectors try to examine all registered hives for the presence of diseases at least once a year. State laws usually require that colonies infected with American foulbrood be fumigated, rendered, or destroyed.

Diseased equipment can be fumigated with ethylene oxide, *if* it is done with the consent and supervision of the Chief Apiary Inspector. There is one fumigation

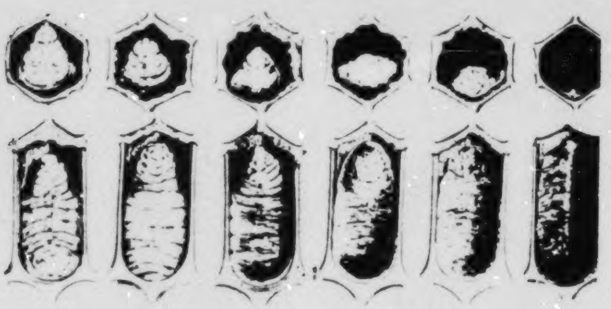


Figure 2. American foulbrood: end and top views of larvae showing progress of decay from the normal condition to the scale.

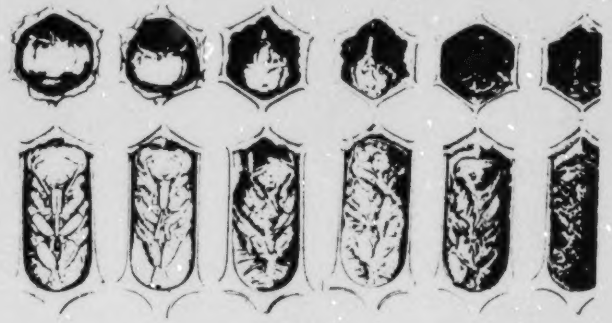


Figure 3. American foulbrood: end and top views of pupae showing progressive stages from the normal condition to the scale.

chamber in Oregon and one in Washington. Contact the Commodities Inspections Divisions, Oregon Department of Agriculture, Agriculture Buildings, Salem, OR 97321 or the Division of Plant Industry, Washington State Department of Agriculture, 2015 South First Street, Yakima, WA 98903. It may be permissible to save the bees in your state. Such colonies *must* be given the gorging treatment with medicated syrup and provided with antibiotic extender patties. Bees placed in fumigated equipment should also be medicated.

Honey bee colonies infected with American foulbrood normally *cannot* legally be medicated. State inspectors will *only* give permission to treat diseased colonies if you have arranged for the colonies to be fumigated with ethylene oxide under inspector supervision.

If a beekeeper wants to reclaim some of his disease-contaminated equipment, the keeper should seek the advice of the State Bee Inspector in the area. *All* diseased equipment should be brought to the attention of the inspector *before* any attempt is made to salvage. Sometimes hive parts can be salvaged under prescribed conditions.

The technique used for killing colonies is to place 1 tablespoon of calcium cyanide on a piece of cardboard and shove it into the hive entrance after dark. Close all openings to the hive to prevent bees from escaping from the colony. Do *not* apply calcium cyanide or any other poison with a dust gun.

Calcium cyanide has not been readily available in recent years. Resmethrin, a synthetic pyrethyroid has been developed as a safer material for beekeeper use. Resmethrin is currently available from some bee supply outlets.

Clothes moth or paradichlorobenzene (PDB) crystals can also be used to kill colonies. The method is essentially the same as that for calcium cyanide.

Place the dead bees and hive contents in a pit and burn them. Cover the ashes with 2 feet of dirt. *Fumes from calcium cyanide are poisonous. Do not inhale.*

Honeycomb AFB test. Sunken and perforated cappings sometimes occur in old, dried-out combs even though American foulbrood was not involved in death of the brood. This is of particular concern when buying used bee equipment. P. F. Thurber, Kirkland, Washington has developed a simple test for AFB under such conditions.

First, lightly moisten the combs to be tested. Then, seal them in a plastic bag and warm to about 90° F for several hours. When the bag is opened again, you will get a strong whiff of American foulbrood odor, if diseased material is present.

European foulbrood

EFB is largely caused by a bacterium known as *Streptococcus pluton*, although several secondary microorganisms contribute to its symptoms. Some of these speed the death of the infected bee larva, others its decomposition. EFB sometimes occurs east of the Cascade Mountains but is far more prevalent in the wetter climates west of the Cascades.

Symptoms. Infected larvae normally die in the cells while still curled at the bottom. This disease does not usually attack sealed brood. When the larvae die they take on a grayish-yellow color, and the affected brood may give off a slightly sour odor. Dead larvae flatten against the bottom or side walls of the brood cell. See figure 4. When dry, the scale does not stick to the walls of the brood cell and may be removed easily. When the head of a match is stuck into a dead EFB larva the contents do not form a "rope" as with AFB.

Recently an atypical form of EFB caused by the microorganism *Bacillus alvei* has become a problem to beekeepers in areas of northwestern Washington and parts of western Oregon. Capping on cells containing infected larvae are often sunken and perforated as in AFB, and the larvae become dark brown. Consistency of the larvae is sticky, and sometimes they will rope out with a match stick up to ½ inch. When a larva is killed by atypical EFB, the scale formed is very hard and can generally be removed from the cell. This is not so with AFB.

Control. Strong colonies are usually able to clean out EFB without difficulty, although occasionally even a populous colony may be reduced in numbers by this disease. Uniting two or more colonies weakened by EFB strengthens them, enabling them to clean the diseased larvae from the cells. If you cage the queen *in her colony* for a 10-day period, you will free the colony to put

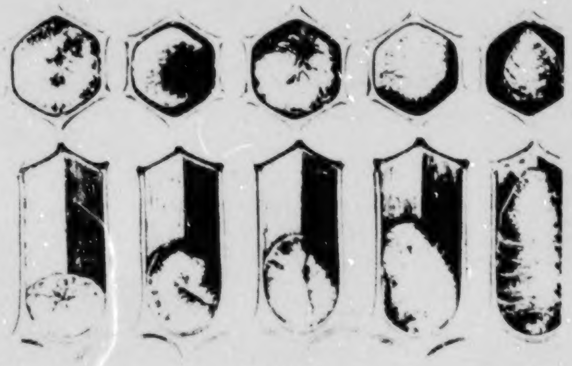


Figure 4. Dead larvae of various stages in the positions that result from European foulbrood.

its house in order; however, you have slowed down the normal growth rate. Requeening with vigorous, young stock is commonly recommended, since the bees will be better able to combat the disease.

Antibiotics have been developed for controlling EFB. With one remedy, you mix thoroughly 1 part of terramycin (Oxytetracycline) TM-25 to 7½ parts of powdered sugar. Other formulations of terramycin (TM-5, TM-10) can be mixed to provide an equivalent dose. Terramycin can be obtained from bee supply dealers. Dust 3 level tablespoons of this preparation over the *ends* of the top bars of the brood frames in the hive. Terramycin is toxic to larvae, *if* it is dusted directly onto them. Infected colonies should be dusted at weekly intervals until they are free of visible disease symptoms. Usually three dustings are enough. *Never medicate a colony immediately prior to or during a honey flow.* Soluble terramycin TM-25 is fed at the rate of 1 level teaspoon per 1⅔ quarts of a 1-to-1 sugar-water syrup (about 5 teaspoons per 2 gallons). *Terramycin loses its strength in syrup in about a week.*

Terramycin has the added advantage of helping to prevent AFB as well as EFB. Most commercial beekeepers use terramycin in annual *early spring* feedings as a disease preventative.

If medication is combined with fall feedings to build up stores for overwintering colonies, use 2-to-1 sugar-water syrup. Such fall feedings should be completed by September 15 in most areas of the Northwest.

Do *not* increase the dosage rate; too much terramycin can kill honey bee broods. Reduced dosages, on the other hand, may lead to the development of resistant disease organisms. Sulfathiazole is ineffective against EFB.

Chalkbrood

Brood diseases caused by fungi were not previously a major problem to beekeepers in the United States. Chalkbrood, a fungal disease of honey bee larvae and pupae has recently been reported from many states. This disease is caused by the fungus *Ascosphaera apis* which was not known to occur in this country until 1967. A very similar disease associated with other species of *Ascosphaera* is now causing severe problems for the commercially managed alfalfa leafcutting bee in certain areas.

Symptoms. Drone brood and recently sealed worker larvae are most susceptible to chalkbrood. The infected brood dries down to a mummified condition and often turns white. After the larvae die, they may turn dark brown or black. This coloration is caused by the appearance of the spore structures of the fungus just under the outer surface of the dead larval bodies. Rarely is more than 5% to 10% of the brood affected. When greater amounts of brood are killed, the deaths are often associated with low temperature and moisture stress conditions. House bees are able to remove the dead larvae from their cells.

Control. There are no established chemical control agents for chalkbrood. Symptoms usually disappear during the summer as worker bees remove the infected brood from the colony. The disease may be combated through these general practices:

- Requeen with a young queen.
- Replace heavily infected combs with similar stage combs from a healthy colony.
- Get rid of larval mummies which are a source of fungus spore contamination.
- Don't use commercial pollen which is contaminated with chalkbrood fungus material.

Sacbrood

Sacbrood usually appears during the spring or early summer. It is rarely found after mid-season. While considered less serious than other brood diseases, sacbrood may so weaken a colony that the bees will produce little or no honey. The disease is caused by a filterable virus and is not accompanied by a characteristic odor.

Symptoms. Sacbrood attacks only the older larvae, most of which die in the 2-day period before pupation. Their color changes to brown and their skin toughens. Dead larvae form brown scales in the cells.

Control. Dead larvae may easily be removed with a match or a toothpick. A strong colony easily cleans out all the cells containing dead larvae. When a colony has become weakened, requeen it to produce a strong force of young bees to clean up the disease. Neither sulfathiazole nor terramycin has an effect on this disease.

ANTIBIOTIC TREATMENTS

Obviously, larvae should be fed a drug if they are to be protected from brood diseases. A direct transfer of the drug to the larvae is not possible. We rely on placing the drug at the disposal of the nurse bees which then pass it to the larvae.

Gorging bees with medicated syrup

One method which is more efficient than bulk feeding systems is to spray or sprinkle medicated syrup directly onto the bees. Bees are apt to store syrup from a feeder in combs.

To spray bees, tip the hive over backwards to a horizontal position. Return the bottom board and the first brood chamber to their original positions. Direct a 1-to-2 sugar-water syrup containing medication down into the interspaces until all bees are wet. Use lukewarm (about 100°F) syrup and do *not* apply gorging treatments on cool days. Do *not* use honey syrup which may lead to robbing. Repeat the spray application for each set of combs as you reassemble the hive. Use as much syrup as will coat the combs without running out the entrance, from 1 pint to 2 quarts, depending upon the size of the colony. Use a small, high-pressure hand sprayer equipped with a coarse nozzle that will deliver about 1 pint of liquid per minute. Do *not* use a sprayer which has previously been used for pesticides.

In the "double treatment," a second spraying or sprinkling is applied to the bees soon after they have cleaned themselves and the combs of the first syrup, usually in about 20 to 30 minutes. To clean up the second application, bees in a populous two-story colony late in the spring will be forced to regurgitate the medicated syrup into cells throughout the brood-rearing area. This second spraying is called "gorging." It greatly increases the chances of the medicated syrup being fed to all the young larvae. As can be seen, this method of administering an antibiotic is quite laborious and not practical if many colonies are to be treated at one time.

Treatments should be repeated at least three times at 3- to 7-day intervals. This gives the colony time to clean out the diseased larvae that would be a source of reinfection. With brood diseases, the gorging treatment should be used primarily as a preventive measure, but it may also cure infestations of European foulbrood. This method is also valuable for Nosema disease, since all the adult bees ingest the Fumidil-B. Gorging is best accomplished late in the day to minimize the chances of bees from other colonies robbing infected honey.

Medicated extender patties

Another excellent method for getting an antibiotic to the larvae is the medicated extender patty. Patties are longer lasting than syrup or dusting for continuous treatment. They are used very early in the spring and should be completely consumed well before the first nectar flows. They can be prepared as follows:

1. Mix ¼ pound powdered sugar with 1 tablespoon TM-25.
2. Cut in ¼ pound of shortening and blend well.
3. Divide into two parts and drop each into a waxed paper sandwich bag (or between two sheets of waxed paper).
4. Roll out to ¼ inch thick.

Feed the prepared patties in the early spring by placing one over the brood nest area of each hive body.

APIARY REGISTRATION

Responsibilities

State Departments of Agriculture are responsible for inspecting bees to determine the presence of foulbrood. They are also responsible for information on moving live bees from one state to another. To assist in these duties it is state law in Oregon, Washington, and Idaho that beekeepers register their hives with their respective Department of Agriculture. Requests for information on these matters should be made to the Chief Apiary Inspector, Department of Agriculture, Agriculture Bldg., Salem, Oregon 97310 or 2015 South First St., Yakima, Washington 98903 or to the State Entomologist, P.O. Box 790, Boise, Idaho 83705.

Registration should be made on or before April 1 of each year. Oregon and Idaho charge a registration fee. Cooperation in registering colonies is to your benefit. Apiary inspectors have the responsibility of carrying out and enforcing provisions of Washington, Idaho, and Oregon Agricultural Codes.

Shipping samples for diagnosis

If you suspect the presence of a disease, send samples of brood or adult bees for examination to Honey Bee Pesticides/Diseases Research Unit, USDA-SEA, University Station, Box 3168, Laramie, Wyoming 82077.

For brood disease diagnosis, cut about a 4-inch square comb sample containing the affected brood or brood remains. Make certain that no honey is present and that the comb is not crushed. For adult disease diagnosis, send approximately 100 sick or dead bees. Mail all samples in a wooden or sturdy cardboard box. Do not use tin, glass, plastic, aluminum foil, or waxed paper. These materials promote mold growth that increases the difficulty of making a satisfactory diagnosis. Write your name, address, and ZIP code clearly on the box. If your State Inspector forwards the sample, his name, address, and ZIP code should also appear on the box or in an accompanying letter.

Trade names have been used to simplify the presentation of information. No endorsement of products is intended.

DIVISION 55

BEES AND OREGON STANDARDS OF BEE COLONY STRENGTH FOR COLONIES USED IN COMMERCIAL POLLINATION OF CROPS

Bees

603-55-005 (1) As used in this rule:

(a) European foulbrood shall be deemed serious if 20 or more larvae are found dead from this disease and more than 20 percent of the cells in the capped brood area are vacant.

(b) A queen shall be deemed a normal laying queen if her eggs that are in the worker cells are producing worker bees as indicated by the brood present.

(2) Oregon *Standard* (or A Grade) Field colony of bees for pollination shall be one that meets the following requirements:

(a) Free from American foulbrood and not seriously infected with European foulbrood or other bee disease.

(b) 3000 square inches of comb, 1000 square inches of which shall be occupied by live brood.

(c) Bees to cover well all brood. There shall be enough bees to cover well 10 standard Hoffman frames of comb or their equivalent.

(d) 10 pounds of honey or its equivalent of suitable bee food other than pollen or pollen substitute.

(e) A normal laying queen present.

(3) Oregon *B Grade* Field colony of bees for field crop pollination shall be one that fails to meet the requirements of a standard field colony on amount of bees and brood by not over 25% but does meet all other requirements of a standard field colony.

(4) Oregon *Standard* (or A Grade) Orchard colony of bees for orchard pollination purposes shall be one that meets the following requirements:

(a) Free from American foulbrood and not seriously infected with European foulbrood or other bee disease.

(b) 3000 square inches of comb space of which 600 square inches shall be occupied by live brood.

(c) Bees to cover well all brood. Bees to cover well at least 6 standard Hoffman frames of comb or their equivalent.

(d) 10 pounds of honey or its equivalent in suitable bee food other than pollen or pollen substitute.

(e) A normal laying queen present.

(5) Oregon *B Grade* Orchard colony of bees for orchard pollination shall be one that fails to meet requirements for a standard orchard colony by not more than 25% on amount of bees and brood but does meet all other requirements of a standard orchard colony.

(6) To allow for variations incident to proper grading, a tolerance of 10% shall be allowed on all defects other than disease and queens.

Stat. Auth.: ORS Ch.
Hist: AD 424, f. 7-10-51, ef. 7-20-51; AD 643, f. 8-17-60; AD 644, f. 10-20-60

Quarantine

603-55-010 (1) The fact has been determined by the State Department of Agriculture of the State of Oregon, that Acarine disease, caused by the mite *Acarapis woodi* Rennie, is one of the most serious diseases affecting the honeybee and in certain areas abroad it has been so destructive that it has virtually wiped out the apiculture industry in heavily infested localities and that certain species of honeybees are host carriers of such mite and that such dread disease is not now prevalent in the State of Oregon. The Secretary of Agriculture of the United States has not established a quarantine relative to this disease.

(2) Now, therefore, I, James F. Short, Director of the Department of Agriculture, Salem, Oregon, under the authority of, but not limited to, ORS 561.510 and 570.305, consider it necessary in order to prevent the introduction and spread of Acarine disease into and within the State of Oregon, do hereby establish a quarantine at the boundaries of the State of Oregon against the mite, *Acarapis woodi* Rennie and against honeybees of the species *Apis indica*, *Apis florea*, and *Apis dorsata*, and all subspecies thereof, which have originated from or have been shipped from any country or land outside of the boundaries of the United States. It shall be unlawful for any person, firm, or corporation to carry, import, or transport into the State of Oregon the mite *Acarapis woodi* Rennie or the species or subspecies of the above three listed honeybees which have originated from or been shipped from any country or land outside of the boundaries of the United States.

(3) Violation of the provisions of this quarantine or ORS 561.590, is punishable, upon conviction, by a fine of not less than $50 nor more than $250.

Stat. Auth.: ORS Ch.
Hist: AD 643, f. 8-17-60

Eradication of Apiary Disease by Fumigation

603-55-015 As provided in subsection (3) of ORS 602.030, the following procedures and conditions shall apply to the eradication of apiary diseases:

(1) Upon the issuance of the notice and order to eradicate a disease in an apiary, as prescribed in subsection (2) of ORS 602.030, the person to whom the notice and order is issued shall select whether burning or fumigation is to be used to eradicate the disease. The selected method shall be carried out in accordance with subsection (2) or subsections (3) and (4) of this section, and within the time specified in the notice and order.

(2) If the selected method of eradication is burning, the following shall apply:

(a) All bees shall be destroyed, and brood, combs, frames, honey and wax shall be burned, with the ashes therefrom buried;

(b) No live bees shall be shaken or otherwise removed from the infected equipment onto other clean equipment; and

(c) The top and bottom boards and superbodies may be saved from burning if they are cleaned and scorched so as to remove all traces of wax, honey or other foreign matter.

(3) If the selected method of eradication is fumigation, the following shall apply:

(a) All bees shall be destroyed by burning at the site (there shall not be any removal of live bees to the fumigation location) and the ashes therefrom buried;

(b) No live bees shall be shaken or otherwise removed from the infected equipment onto other clean equipment;

(c) The equipment to be fumigated must be secured from entry by other bees (e.g., sealed in plastic, openings nailed shut, etc.);

(d) Fumigation shall be performed within six weeks of the issuance of the notice and order, and it shall be the sole responsibility of the person to whom the notice and order was issued to arrange for the operator of a fumigator to act within that time;

(e) Within 72 hours after fumigation is completed, the person to whom the notice and order was issued, or the operator of the fumigator on his behalf, shall notify the Department (apiary inspector) that the fumigation has been completed; and

(f) No fumigated equipment shall be moved from the fumigation location until a numbered certificate (on a form approved by the Department) has been issued by the operator of the fumigator, and until all fumigated equipment has been first permanently marked so as to identify it as having been fumigated.

(4) The operator of an apiary fumigator shall comply with and be governed by the following:

(a) Upon application of the operator, the Department shall inspect the location, materials and equipment intended to be used by the operator for fumigation, and review the operator's intended fumigation procedures, and if approved by the Department, the operator's location, materials, equipment and procedures shall be certified as approved for apiary fumigation;

(b) Any subsequent change in location, materials, equipment or procedures of a fumigator shall also be certified by the Department before being utilized;

(c) The operator of a fumigator, as a private businessman, may establish his own working hours, service charges, recordkeeping procedures, and other usual business practices, but he shall prepare and maintain complete and accurate records of persons for whom apiary fumigation has been performed, the times of such fumigations, and descriptions of the equipment fumigated; and

(d) The records of the fumigator operator shall be available for inspection by the Department during usual business hours.

Stat. Auth.: ORS Ch. 561
Hist: AD 26-1981, f. & ef. 12-9-81

1379

Chapter 602

1981 REPLACEMENT PART

Bees

GENERALLY

602.010 Definitions
602.020 Chief Apiary Inspector
602.030 Inspection of apiaries; notice to eradicate disease; eradication; quarantine
602.040 Diseased apiary declared public nuisance; abatement; limitations on moving diseased bees
602.050 Laboratory test for existence of American Foulbrood
602.060 Prohibited conduct
602.070 Movement of bees; notice; inspection
602.081 Importation of bees or used apiary equipment or appliances
602.083 Quarantine of imported bees, appliances
602.085 Exceptions to quarantine of bees, appliances
602.087 Diseased bees discovered during quarantine; notice of seizure; disposition
602.090 Registration of apiaries
602.100 Establishing standards of colony strength; certification of hives
602.110 Registration of apiary equipment
602.120 Issuance of brand or serial number certificate
602.130 Identification of hive bodies, supers and frames
602.140 Transfer of ownership of apiary equipment
602.150 Prohibited conduct relating to brands and serial numbers
602.160 Posting registration number or statement of ownership
602.170 Jurisdiction of courts
602.180 Disposition of fees

DISEASE CONTROL

602.210 Authority to seize apiary property
602.220 Notice of seizure
602.230 Disposition of seized apiary property
602.240 Department not responsible for loss or damage
602.250 Claim by owner; reimbursement
602.260 Title of apiary property sold by department
602.270 Temporary custody of apiary property; notice; reimbursement
602.280 Costs to be paid from sale proceeds; disposition of balance

PENALTIES

602.990 Penalties

CROSS REFERENCES

Administrative procedures governing state agencies, 183.310 to 183.550
Agricultural products, marketing, Ch. 576
Bees and honey as commodity, 576.051
Enjoining violations of law, 561.280
Insect sting treatment program, 433.805 to 433.830

602.990

Jurisdiction over prosecutions, 561.290

GENERALLY

602.010 Definitions. As used in this chapter, the term:

(1) "Apiary" and "apiary property" includes bees, honey, beeswax, bee comb, hives, frames and other equipment, appliances and material used in connection with an apiary.

(2) "Apiarist" means any person, firm or corporation who owns bees or is a keeper of bees.

(3) "Appliances" means any implement or device used in the manipulating of bees or their brood or hives, which may be used in any apiary.

(4) "Bees" means honey-producing insects of the genus Apis and includes the adults, eggs, larvae, pupae or other immature stages thereof, together with such materials as are deposited into hives by their adults, except honey and beeswax in rendered form.

(5) "Colony" or "colonies of bees" refers to any hive occupied by bees.

(6) "Department" means the State Department of Agriculture.

(7) "Disease" means American or European Foulbrood or any other disease or any condition affecting bees or their brood which may cause an epidemic.

(8) "Hive" means any receptacle or container made or prepared for use of bees, or box or similar container taken possession of by bees.

(9) "Inspector" means any person authorized to enforce the provisions of this chapter.

(10) "Location" means the premises upon which an apiary is located.

(11) "Person" includes any individual, partnership, association or corporation, but does not include any common carrier when engaged in the business of transporting bees, hives, appliances, bee cages or other commodities which are the subject of this chapter, in the regular course of business. [Amended by 1961 c.177 §1; 1963 c.65 §1]

602.020 Chief Apiary Inspector. The department is authorized to appoint a Chief Apiary Inspector and such deputy apiary inspectors as may be necessary to carry out this chapter. The administration of such sections by the Chief Apiary Inspector shall be under the direction and control of the Director of Agriculture. [Amended by 1961 c.177 §2]

602.030 Inspection of apiaries; notice to eradicate disease; eradication; quarantine. (1) The Chief Apiary Inspector shall make, or cause to be made, whenever necessary, inspections of all apiaries.

(2) Whenever a disease exists in any apiary, the inspector making the inspection shall mark the hives containing diseased bees. The inspector shall, in writing, notify the owner or person in charge of such apiary, stating in the notice the nature of the disease found in each colony, identifying such colony by reference to the mark placed upon the hive thereof, and ordering the eradication of such disease within a specified time. When the person in charge of any apiary is not known, the notice shall be served by posting in a conspicuous place in the apiary or mailing a copy to the owner's registered address.

(3) The owner or person in charge of any diseased apiary must eradicate such disease within the time specified in the notice. Unless fumigation is to be the method of eradication, and if the disease is American Foulbrood, the time specified in the notice shall not be less than 24 hours nor more than 120 hours from the time of serving notice. Eradication of American Foulbrood shall be by burning the diseased colonies, including the bees, brood, combs, frames, honey and wax, and by burying the ashes and disinfecting the hives by means approved by the department, or by fumigation in the manner and under the conditions specified by the department. In addition to the requirements of subsection (2) of this section, the notice shall set forth the specified methods and conditions for fumigation, and the time within which it must take place.

(4) Any apiary which is found to contain five percent or more colonies of bees infected with American Foulbrood may be summarily quarantined by the department. Colonies of bees which have died because of such infection shall be counted in computing the percentage of colonies infected. Notice of the quarantine shall be posted prominently on the apiary, and the owner notified of such quarantine. During the quarantine no bees, honey, equipment or other materials may be removed from the apiary, except under the supervision of an inspector, and for the purpose of eradicating the disease. The quarantine shall be removed when an inspection by the department made at least 30 days after the last previous inspection shows the apiary apparently free from

American Foulbrood. [Amended by 1953 c.400 §7; 1981 c.164 §1]

602.040 Diseased apiary declared public nuisance; abatement; limitations on moving diseased bees. (1) Every apiary in which diseased bees are found is declared to be a public nuisance. Whenever any such nuisance exists and the owner refuses or neglects, after notice by an inspector to abate it within the time specified in the notice issued under ORS 602.030, the inspector shall abate it by burning the condemned hives and their contents, including bodies, bottom boards, covers and supers, within 48 hours after the expiration of the time specified in the notice. During the period of time specified in such notice and during any extended time permitted under the provisions relative to an appeal for diagnosis as provided by ORS 602.050, no person shall remove any of the hives or their contents which are marked to indicate infestation with American Foulbrood, except that the hive or its contents may be removed by the owner or bailee for the purpose of destroying it under the supervision of an inspector.

(2) If, upon inspection of an apiary, European Foulbrood is found to exist therein to a serious extent, no colonies shall be removed from such apiary except under the supervision of an inspector and after affected colonies have been treated in a manner which shows the disease is being eradicated. [Amended by 1953 c.400 §7]

602.050 Laboratory test for existence of American Foulbrood. The inspector may take a sample of material from any hive suspected of containing American Foulbrood. Such sample shall be submitted to the department or to a laboratory designated by the department to test for the presence of American Foulbrood. The findings of the department or the designated laboratory shall be deemed prima facie correct.

602.060 Prohibited conduct. (1) No person shall:

(a) Possess any bees which have not been registered as provided by ORS 602.090;

(b) Interfere with any inspector engaged in the performance of his duties pursuant to this chapter;

(c) Keep bees in hives with immovable combs;

(d) Damage or destroy bees or their equipment by poison, by moving them a short distance or by any other means. Any person violating this provision is liable for the damages, which may be recovered in an action at law; or

(e) Place in any combless package of bees offered for sale or distribution in this state any food, article or substance containing honey.

(2) No person in possession of an appliance, hive or equipment contaminated with any disease shall negligently or wilfully expose or handle such appliance, hive or equipment in a manner which will permit bees to become infected with such disease.

(3) No person shall carelessly or negligently expose combs wet with honey or combs containing honey or pollen to bees. [Amended by 1953 c.400 §7; 1961 c.177 §3]

602.070 Movement of bees; notice; inspection. (1) No person shall move bees from one location to another within this state without notifying the department, in writing, of such movement within five days after moving the bees. The written notice shall state the number of colonies moved, the location from which and to which the bees were moved and proper directions for locating the bees.

(2) When the department receives notice of a movement of bees it shall, if it deems it necessary, make an inspection of such bees for the presence of disease.

(3) When an inspection is requested by any person for the purpose of obtaining a certificate of inspection for out of state movement of bees or appliances, the applicant for such certificate shall pay the cost of inspection, including per diem and traveling expenses of the inspector. [Amended by 1953 c.400 §7]

602.080 [Repealed by 1953 c.400 §7]

602.081 Importation of bees or used apiary equipment or appliances. No person shall bring or cause to be brought into the State of Oregon bees or used apiary equipment or appliances, excepting used packaged bee cages returned empty to this state, without an accompanying certificate of health as approved by the department, made within 60 days prior to such movement, by an authorized inspector or other officer of the state or country in which the movement originated, stating that such bees, equipment and appliances are free from disease. [1961 c.177 §5]

602.083 Quarantine of imported bees, appliances. (1) All bees and appliances imported into this state shall be placed in quarantine not to exceed 30 days in a location or place designated and approved by the department. Any person importing bees or appliances shall obtain approval from the department prior to importation.

(2) The department shall establish reasonable provisions relating to and covering bees and appliances in quarantine. Bees or appliances, including those in quarantine, are subject to the provisions of this chapter.

(3) If the department verifies that a person owning or possessing imported bees has violated any provision of this chapter, it may, notwithstanding other provisions of law, suspend for a period not to exceed two years the right of such person to again import bees or appliances. [1967 c.123 §2]

602.085 Exceptions to quarantine of bees, appliances. The provisions of ORS 602.083 do not apply to:

(1) A person or the bees or appliances he owns or controls, if such bees are brought into this state as "combless packages of bees." "Combless packages of bees" means bees, which may include a queen bee, packed for shipment and imported into this state in packages which contain no honey, honeycomb, broodcomb, or appliances previously used on bees.

(2) Bees and appliances registered with the department, which, after being moved or transported out of state, are moved or transported back into Oregon within five months, if they are accompanied into Oregon by a health certificate issued by an authorized official of the other state approved by the department.

(3) Oregon registered bees absent from this state for two months or less. A health certificate for Oregon registered bees and appliances described in subsection (2) of this section is not necessary when they are returned or moved or transported back into Oregon if, during their absence from Oregon they have not been brought into contact with or commingled with bees or appliances in the other state that are not covered by a health certificate. [1967 c.123 §4]

602.087 Diseased bees discovered during quarantine; notice of seizure; disposition. (1) If at any time during the quarantine as authorized in ORS 602.083 the department determines that two percent or more of the colonies of bees under quarantine are infected with American or European Foulbrood, the department shall seize said bees and shall notify the owner or person in possession of the bees in writing that:

(a) The department has seized the infected colonies of bees, that they are declared to be a public nuisance and they shall be destroyed and the nuisance abated as authorized or required under ORS 602.040 (1), and

(b) The department has seized the remaining colonies of bees under quarantine and all such colonies are to be removed from Oregon within 10 days of the date of such notice, and that if they are not removed within such period, the colonies will be disposed of by the department as authorized and required by ORS 602.210 to 602.260.

(2) Colonies of bees which have died because of infection with American Foulbrood shall be counted in computing the percentage of colonies infected. [1967 c.123 §3]

602.090 Registration of apiaries. (1) Every person who owns or is in charge of any apiary located within this state, shall cause such apiary to be registered with the department as in this section provided.

(2) Application for registration shall be made on a form furnished by the department. The registration shall cover each colony of bees owned by the applicant, and shall give the locations of such colonies and the name and address of the owner. The registration shall be made before April 1 of each year and whenever colonies are acquired from sources other than his own registered apiaries thereafter. Each registrant shall furnish an address to which any notice required by this chapter to be given may be sent, and shall agree that any notice sent by the department to such address shall be deemed to be notice in fact.

(3) The application for registration shall be accompanied by a fee of $1 per applicant. The application shall also be accompanied by a colony registration fee of 15 cents for each colony of bees owned by the applicant over six in number.

(4) When the ownership of bees which have been subject to the charge provided in this section is changed, the department may transfer the registration to the new owner without charges. However, if the new owner has not been previously registered, he shall

pay the registration fee of $1. [Amended by 1953 c.400 §7; 1961 c.177 §6; 1963 c.65 §2]

602.100 Establishing standards of colony strength; certification of hives. (1) The department shall, after public hearing, establish standards of colony strength for apiaries used in the commercial pollenization of agricultural and horticultural crops.

(2) For purposes of this section "colony strength" has reference to the potential of a hive of bees to pollenize horticultural or agricultural crops. Standards of colony strength shall be based upon, among other things:

(a) The number of bees per hive.

(b) The number of cells containing brood per hive.

(c) The health of the bees and the brood.

(d) Such other factors as may relate to the ability of the colony to pollenize horticultural and agricultural crops.

(3) The department may at such places as the volume of business is found to warrant the furnishing of such work, provide qualified inspectors who shall carry on colony strength certification work. The department may identify and certify hives of bees used in commercial pollenization on the basis of colony strength. The department shall establish a schedule of fees to cover the cost of inspection and certification of hives for colony strength.

602.110 Registration of apiary equipment. (1) Upon receipt of an application of any person therefor, accompanied by a fee of $1, the State Department of Agriculture shall register, in a registration book kept in its office for that purpose, the apiary equipment identifying brand of such applicant, if a certificate for such brand has not been previously issued. Any person owning apiary equipment who, prior to July 5, 1947, was not in possession of any established apiary equipment identifying brand, may make application to the department for a serial-number brand therefor.

(2) Upon receipt of any application for the issuance of a serial-number brand, accompanied by a fee of $1, the department shall issue to the applicant, an exclusive apiary equipment serial number and shall register it as provided by this section.

(3) Every application for the registration of an apiary equipment brand or for an apiary equipment serial number shall contain the name and address of the applicant and the name of the county in Oregon in which such applicant regularly keeps the greatest number of bee colonies. Such information shall be registered, together with the brand or apiary equipment serial number of such applicant.

602.120 Issuance of brand or serial number certificate. Upon the registration of the brand or the issuance of an apiary equipment serial number as provided by ORS 602.110, the State Department of Agriculture shall issue to the applicant a certificate setting forth a concise description of the brand or the serial number. The possession of this certificate entitles the person in whose name it is issued to the exclusive and sole use of the brand or apiary equipment serial number described or set forth in it.

602.130 Identification of hive bodies, supers and frames. Every person who is in possession of an apiary equipment brand or apiary equipment serial number, as provided by ORS 602.110, shall identify all hive bodies and supers by burning a replica of the apiary equipment brand or apiary equipment serial number on both ends of all hive bodies and supers. Such replica shall be not less than one-half inch in height. Such persons may identify frames with the replica of the brand or serial number permanently on the top bars thereof. A replica of the brand or serial number may be permanently placed on any other equipment in any manner or position desired.

602.140 Transfer of ownership of apiary equipment. (1) In case of a transfer of ownership of any apiary equipment by the possessor of a registered and certified brand or serial number, a copy of the bill of sale specifying the equipment transferred, as to identification and amount, shall be forwarded by registered mail to the State Department of Agriculture. The department shall record such bill of sale in a book kept in its office for that purpose.

(2) In no case, after any such transfer of apiary equipment, shall the replica of the original brand or serial number be defaced or obliterated. The brand or serial number, if any, of the new owner, shall be placed below the original brand or, if that is not possible, then as near to the original brand as can conveniently be done.

602.150 Prohibited conduct relating to brands and serial numbers. No person shall:

(1) Alter, deface, remove or obliterate the

replica of a registered brand or serial number which appears on any apiary equipment, with the intent to steal it or prevent the identification thereof.

(2) Have in his possession any apiary equipment upon which appears a replica of any registered brand or serial number, unless such person is the possessor of a certificate of registration for such brand or serial number issued by the State Department of Agriculture, if a bill of sale for such apiary equipment has not been previously forwarded to the department as provided by ORS 602.140.

(3) Have in his possession any apiary equipment which has previously borne the replica of a registered brand or serial number, but which brand or serial number has been altered, defaced, obliterated or removed.

602.160 Posting registration number or statement of ownership. Any owner or possessor of an apiary in which there are hives that are not marked with a registered brand or apiary equipment serial number, shall, unless such apiary is located at the owner's place of residence or beekeeping headquarters, post and keep posted in a prominent place at each apiary, in figures at least one inch high, the registration number issued by the State Department of Agriculture which currently applies to the colonies of bees in such apiary. In lieu of posting such registration number, such owner or person in possession may post a statement of the ownership of the apiary giving on it the name and address of the owner.

602.170 Jurisdiction of courts. The district courts and circuit courts have concurrent jurisdiction with justice courts in the enforcement of ORS 602.010 to 602.100.

602.180 Disposition of fees. The department shall deposit all fees paid to it under this chapter into the Department of Agriculture Service Fund. Such fees are continuously appropriated to the department for the purpose of administering and enforcing this chapter, including release and publication of information and material to better acquaint the bee industry with the law and regulations promulgated thereunder. [Amended by 1961 c.177 §7, 1979 c.499 §16]

DISEASE CONTROL

602.210 Authority to seize apiary property. In order to control and eradicate diseases which could cause irreparable damage to the bee industry and to all segments of agriculture of this state, any apiary property within the state which exists in violation of ORS 602.081 or 602.090 may be seized by the department. [1963 c.65 §4]

602.220 Notice of seizure. (1) Whenever apiary property is seized under ORS 602.210, the department shall give notice of such seizure to the owner of the apiary; or, after reasonable effort to ascertain the owner or his address if such owner remains unknown or cannot be located, notice shall be given to the person in possession of the apiary.

(2) Notice of seizure shall:

(a) Be in writing.

(b) Describe the property seized.

(c) Describe the violation involved.

(d) State the time within which the violation must be corrected, which time shall be not less than 15 days from notice of seizure.

(3) A warning to all persons that the apiary property may not be removed, together with a copy of the written notice of seizure, shall be posted in a conspicuous place in the apiary. [1963 c.65 §5]

602.230 Disposition of seized apiary property. If the violation charged is not corrected within the time prescribed by the notice of seizure, the department may dispose of the apiary property in the following manner:

(1) The department shall give written notice to the owner or to the person in possession of the apiary that the seized property will be disposed of by public sale at a stated time and place not less than 10 days from date of such disposal notice.

(2) If the owner remains unknown or cannot be located, the department shall also, not less than 10 days before the sale, cause a notice of such disposal sale to be published in a newspaper of general circulation in the county where the apiary is located.

(3) The apiary property shall be sold to the highest bidder, taking into consideration written bids received before the time of sale and oral bids at the sale. However, any person submitting a bid must agree to comply with the provisions of this chapter before his bid will be acknowledged.

(4) If there is no acknowledged bid and if the apiary property is not otherwise disposed of under the provisions of ORS 602.270, the department may dispose of such property in any other manner it deems necessary including destruction without indemnity to any person. [1963 c.65 §6]

602.240 Department not responsible for loss or damage. The department shall not be responsible for any loss or damage to the apiary property during seizure or disposal. [1963 c.65 §7]

602.250 Claim by owner; reimbursement. If the owner appears and files a written claim with the department for the apiary property before the time of sale, he must, within 24 hours before the scheduled time of sale, reimburse the department for its actual costs already incurred and comply with the notice of the department before he is given control and custody of the apiary property. If the owner fails so to reimburse and comply, the sale shall be carried out as in cases where the owner does not appear. [1963 c.65 §8]

602.260 Title of apiary property sold by department. The purchaser of the sold apiary property shall have clear and absolute title to the apiary property upon receiving a bill of sale from the department. [1963 c.65 §9]

602.270 Temporary custody of apiary property; notice; reimbursement. (1) Notwithstanding ORS 602.210 and 602.220, when it is necessary for the department, or persons under its supervision, to feed bees in order to maintain colony strength or to prevent them from dying, the department may, without charge therefor, give temporary custody of the seized apiary property to any person who will maintain it in compliance with this chapter.

(2) Within 10 days after such emergency disposal the department shall notify in writing the owner or person in possession of the apiary of such disposal. If the owner is unknown or cannot be located, the department also shall cause a notice of such disposal to be published in a newspaper of general circulation through the area where the apiary was located within 10 days after disposal.

(3) If the owner appears and files a written claim with the department within 30 days after such disposal, he must within such 30-day period reimburse the person maintaining the apiary property for costs actually incurred before such owner is given control and custody of the apiary property.

(4) If the owner does not comply with the provisions of subsection (3) of this section, the person maintaining the apiary property shall have clear and absolute title thereto upon receiving a bill of sale from the department. [1963 c.65 §10]

602.280 Costs to be paid from sale proceeds; disposition of balance. (1) All costs incurred by the department in the seizure and sale of the apiary property, including salary and mileage of department personnel, shall be paid from the proceeds of the sale.

(2) If the proceeds of the sale are inadequate to pay all of the costs incurred by the department, the department shall pay the deficiency from funds available under this chapter.

(3) Any balance remaining from the proceeds of the sale shall be paid to the owner of the apiary property. If the owner is unknown or cannot be located, the balance shall be held by the department for a period of two years.

(4) If the owner fails to establish his right to the proceeds within two years after the date of sale of the apiary property, all right, title and claim thereto shall vest in the department to use in carrying out this chapter. [1963 c.65 §11; 1967 c.637 §20]

PENALTIES

602.990 Penalties. (1) Violation of any of the provisions of ORS 602.010 to 602.100 is punishable, upon conviction, by a fine not exceeding $500 or imprisonment in the county jail not exceeding six months, or both.

(2) Violation of any of the provisions of ORS 602.110 to 602.160 is punishable, upon conviction, by a fine not exceeding $100 or imprisonment in the county jail for not less than 10 days nor exceeding six months, or both.

CHAIN SAWS

Instructor's Guide:

1. Read all material presented in this unit before preparing instruction material.
2. Purchase any supplies that may be needed for proper instruction.
3. Order any audio-visual material needed to enhance further instruction.
4. Contact any resource people that will help in chain saw instruction.

Objectives:

Upon completion of this unit, the student will be able to:

1. Identify the main parts of a chain.
2. Identify four types of cutters and calculate chain pitch.
3. Sharpen a chain and adjust the chain depth and tension.
4. Replace the chain links on a chain saw.
5. Repair a bar on a chain saw.
6. Understand terms associated with chain oilers and types of chain oilers.
7. Name the types and categories of chain oilers.
8. Check a chain oiler for proper operation.
9. Remove, inspect, service and replace a direct drive assembly.

Teaching Aids:

1. "The Chain Saw" Sound Filmstrip #1-391-233 at $32.50:
   Vocational Education Productions
   California Polytechnic State University
   San Luis Obispo, California 93407

2. Douglas Den - Series of 10 films
   18840 N.W. Rock Creek Circle #287
   Portland, Oregon 97229 645-5093

3. Oregon Workers Compensation Films
   Industry and Labor Building
   Salem, Oregon 97300

Student Activities:

1. Read and understand unit objectives.
2. Provide a chain saw for repair and servicing instruction.
3. Develop a section in Ag Notebook for chain saw material.

References:

1. Husqvarna Dealers: Literature
2. Omark Industries: Literature
3. McCulloch Chain Saw Dealers: Literature
4. Stihl Dealers: Literature
5. Douglas Den: Literature
6. Timber Falls Handbook: Workers Compensation Board of B.C.
   5255 Heather Street
   Vancouver, B.C. V52 3L8
7. Timber Cutting Practices: Steve Conway
   Miller Freeman Publications

Appendices:

1. Appendix A: "Main Parts of A Chain"
2. Appendix B: "Types of Cutters"
3. Appendix C: "Main Parts of a Cutter"
4. Appendix D: "Tools Used to Replace a Chain Link"
5. Appendix E: "Types of Bars"
6. Appendix F: "Main Parts of a Bar"
7. Appendix G: "Pulsation Pump"
8. Appendix H: "Cylinder Check Valve Pump"

9. Appendix I: "Cam Operated Pump"
10. Appendix J: "Gear Drive Pump"
11. Appendix K: "Types of Sprockets"
12. Appendix L: "Parts of a Gear Reduction Assembly"
13. Appendix M: "Parts of Direct Drive Assembly"

Terms and Definitions:

1. Chain: cutting assembly on a chain saw.
2. Drive link: chain component which has a tang that meshes with the drive clutch teeth to drive the chain around the bar.
3. Guard link: chain component on semi and micro chisels used instead of the tie strap.
4. Preset cutter: chain component which has a cutting edge and rivets to attach all other components of the chain.
5. Preset tie strap: chain component which connects the drive links and cutters and has rivets to attach other components.
6. Rivet: contains a flange and hubs to fasten the chain components together.
7. Bar: flat, oblong metal part with grooves which provide a race for the chain drive link to follow.
8. Roller nose: bar and piece with a center pivot designed to reduce chain friction by rotating with the chain as it rolls over the end of the bar.
9. Chain pitch: half the distance between the centers of the cutter toe end rivet hole and the next tie strap toe end rivet hole.
10. Depth gauge: portion of the right and left hand cutter which allows the cutting edge to protrude a certain distance into the surface being cut.
11. Filing vise: special tool used for holding the chain so it can be filed and checked for depth.
12. File holder: special tool designed for holding a file to assure correct angle and depth of sharpening.
13. File guide: special tool used for checking and filing the depth gauge.
14. Stroke: forward movement of the file allowing a cutting action to shape the cutter.
15. Cutter angle: the angle at which the cutter is filed during chain sharpening.

16. Joint: distance between top of cutter and top of depth gauge.

17. Pocket chain breaker: block made of hardened steel, grooved so that rivets can be removed easily with a punch.

18. Rivet spinner: tool used to put factory type round finish on rivet heads.

19. Bench chain breaker: bench mounted tool with a power lever attached to a hardened steel type punch to easily remove rivets.

20. Riveting: connecting links in order to form one continuous chain.

21. Groove: portion of the bar in which the drive links run in order to hold the chain into the bar.

22. Body: main part or solid section of the bar.

23. Rail: portion of the bar on which the tie straps of the chain ride enabling the drive links to be guided in a groove.

24. Nose tip: portion of the bar that the chain circles on the tip.

25. Roller tip: special antifriction roller assembly used on some bar tips.

26. Mounting slot: slot in which the bar mounting bolts are received to secure the bar to the engine housing.

27. Adjustment pin hole: hole in the bar in which a chain adjuster fits.

28. Oil delivery hole: hole in bar assembly in which oil is delivered to the bar and chain when the pump is operated.

29. Oiler pump: mechanical device used to force oil from a reservoir to the bar for lubrication during sawing operations.

30. Manual oiler pump: non-automatic oiler pump which is activated by the machine operator.

31. Automatic oiler pump: oiler pump which is driven by some form of engine related force; runs automatically when engine is operating.

32. Oil reservoir: tank which stores oil to be transferred to the bar for lubrication during sawing operations.

33. Regulator valve: adjustable metering device found on some saws; can be adjusted to control amount of oil to bar, and cannot be completely shut off.

34. Check valve: device which allows pressurized fluids to pass in only one direction.

35. Pulsation pump: automatic oiler pump which supplies oil through pressure from a diaphragm which is pulsated by crankcase pressures.

36. Cylinder check valve pump: automatic oiler pump which supplies oil by pressurizing the tank with cylinder pressure through a check valve.

37. Cam operated pump: automatic oiler pump which supplies oil through a reciprocating plunger pump driven by crankshaft cam.

38. Gear drive pump: automatic oiler pump which supplies oil through a reciprocating plunger pump driven by a crankshaft gear.

39. Sprocket: device which the cutter chain drive links ride on or in as the drive assembly transfers crankshaft power to the chain.

40. Centrifugal clutch: power transfer assembly which uses centrifugal force to engage shoes to a drum.

41. Idler gear: gear placed between driving and driven gears in a gear system to maintain direction of rotation of driving gear.

42. Bearing: device used to reduce friction between moving parts.

43. Gear reduction: system of mated gears designed to reduce the output speed and increase the torque of the system before it is applied to work.

44. Direct drive: system using clutch and sprocket assembly to transfer power from crankshaft to chain.

I. Chains

A. The main parts of the chain (Appendix A)

1. Drive link
2. Tie strap (side link)
3. Preset cutter, left hand and right hand
4. Preset tie strap (side link)
5. Rivet

B. Types of cutters (Appendix B)

1. Chipper
2. Chisel
3. Semi and micro chisel
4. Power sharp

C. Main parts of a cutter (Appendix C)

1. Top plate
2. Gullet
3. Depth gauge
4. Rivet hole
5. Toe
6. Heel
7. Side plate

D. Causes of chain failures

1. Chain improperly adjusted
2. Worn or damaged bar groove
3. Lack of lubrication
4. Improper filing or sharpening
5. Abrasion
6. Worn out roller nose
7. Improper use
8. Damaged sprocket teeth

II. Chain sharpening

A. Methods of sharpening chains

1. Hand filing
2. Machine grinding
    a. Study all safety procedures before operating equipment
    b. Study operator's manual before operating equipment

B. Reasons why a chain should be kept sharp

1. Chain saw cuts faster
2. Chain saw cuts smoother
3. Operator fatigue is reduced
4. Wear to bar and sprocket is reduced
5. Noise is reduced

III. Chain link replacement

A. Safety factors for replacing a chain link

1. File the bottom of a new link to match worn links
2. File a new cutter to match the other cutters on the chain
3. If new links are not properly filed to match existing links

    a. Dangerous jerking will occur
    b. Dangerous vibration will occur

B. Tools used for chain link replacement (Appendix D)

1. Pocket chain breaker
2. Bench chain breaker and spinner
3. Hand rivet spinner
4. Multi-purpose tool

    a. Used to punch out rivets
    b. Used to form new heads
    c. Can be used to form a head on a used rivet in some instances where emergency repairs are needed

IV. Bars

A. Types of bars used on chain saws (Appendix E)

1. Solid nose bar
2. External roller nose bar

    a. Must be greased at every fueling

3. Internal roller nose bar

    a. On some models is lubricated by the chain oiler

4. Bow bar

B. Main parts of a typical bar assembly (Appendix F)

1. Groove
2. Body
3. Rail
4. Nose tip

V. Chain oilers

A. Categories of chain oilers

1. Manual

a. This oiler relies on the operator to initiate oiling action

2. Automatic

a. This oiler automatically provides oiling

3. Combination automatic with manual

a. This system automatically oils and can be supplemented by manual action of operator

B. Types of automatic chain oilers

1. Pulsation pump
2. Cylinder check valve pump
3. Cam operated pump
4. Gear drive pump

C. Operation of automatic chain oilers

1. Pulsation pump (Appendix G)

a. Engine crankcase develops a vacuum

1) Diaphragm is drawn inward during vacuum
2) Diaphragm pulls pump piston downward
3) Pump piston vacuum draws oil from reservoir through manual pump into metering chamber

b. Engine crankcase pressurizes

1) Diaphragm is pushed outward
2) Piston is pushed upward blocking oil inlet
3) Piston upward movement pressurizes the metering chamber
4) Pressure forces check valve ball off of seat and oil passes
5) Pressure forces oil through the transfer line to the bar

2. Cylinder check valve pump (Appendix H)

a. Cylinder pressurizes

1) Pressure forces cylinder check valve open
2) Pressure passes through reservoir check valve into oil reservoir

3) Pressure in reservoir forces oil through manual oiler pump
4) Throttle action opens system valve

a) This valve keeps pressure in reservoir from pushing oil to the bar except when the throttle is in use

5) Oil passes through system valve in transfer lines to regulator valve
6) Regulator valve meters oil flow to bar

b. Cylinder develops vacuum

1) Cylinder check valve closes
2) Reservoir check valve closes
3) When closed these valves lock the pressure in the reservoir

3. Cam operated pump (Appendix I)

a. Cam pushes in plunger

1) Cam pushes piston forward
2) Piston seals off inlet port and pressurizes the trapped oil in front of it
3) Pressurized oil forces check ball off seat
4) Oil travels to metering chamber
5) Metering chamber transfer oil to outlet port

a) Oil flow control screw regulates the amount of oil going to the bar by metering the amount of oil returning to the reservoir

b. Cam allows plunger return

1) Piston drops back past inlet port
2) Oil from reservoir comes into pump body

4. Gear drive pump (Appendix J)

a. Crankshaft rotates while engine runs
b. Crankshaft gear drives pump gear
c. Cut cam groove in pump shaft rides on cam screw
d. Rotation of shaft and cam action causes reciprocal strokes
e. Rotating pump shaft flat allows oil to enter at the inlet port while upward movement pulls oil in
f. Further rotation seals inlet port and opens outlet
g. Reciprocal movement from further rotation forces oil to outlet port
h. Outlet port allows oil to flow to bar

VI. Chain saw drives

A. Types of drives

1. Direct
2. Gear reduction

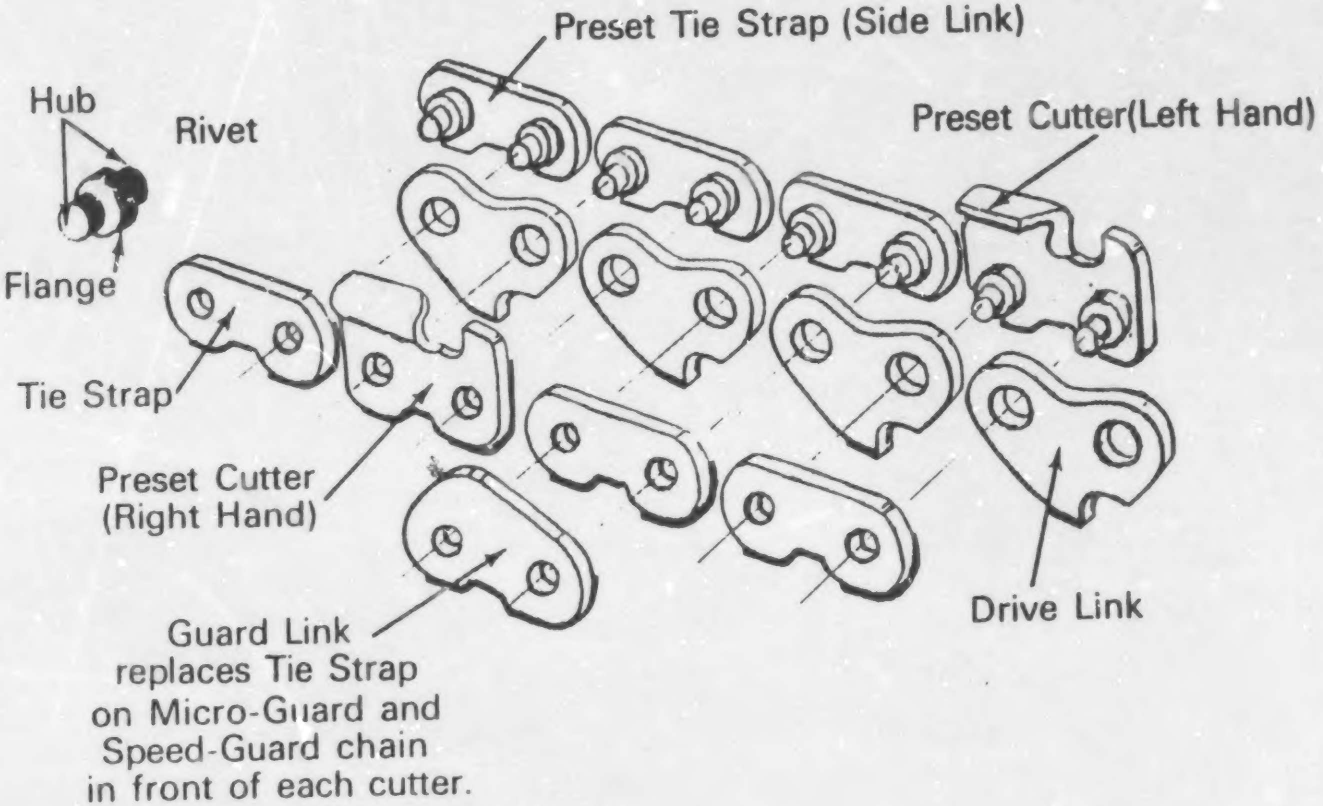
B. Types of drive sprockets (Appendix K)

1. Self aligning
2. Integral star sprocket and clutch drum

C. Parts of a gear reduction assembly (Appendix L)

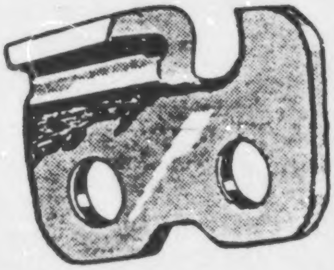
1. Idler gear post
2. Crankshaft
3. Oil pump drive and sprocket gear shaft
4. Idler gear assembly
5. Clutch assembly with drive gear
6. Sprocket gear

Main Parts of A Chain

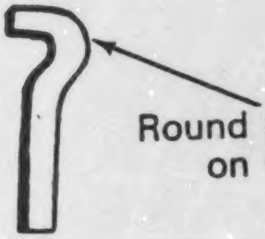

Preset Tie Strap (Side Link)
Hub
Rivet
Preset Cutter(Left Hand)
Flange
Tie Strap
Preset Cutter (Right Hand)
Drive Link
Guard Link replaces Tie Strap on Micro-Guard and Speed-Guard chain in front of each cutter.

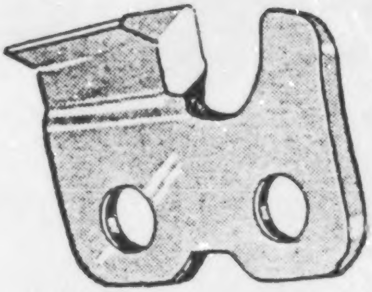
Appendix B

Types of Cutters

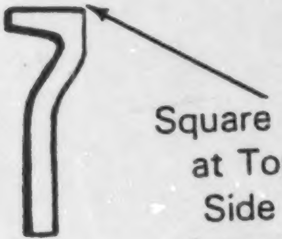


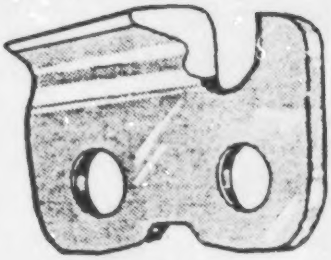
Chipper


Round Side Plate
on Cutter

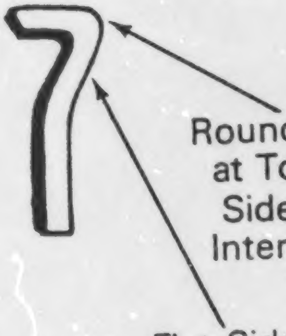


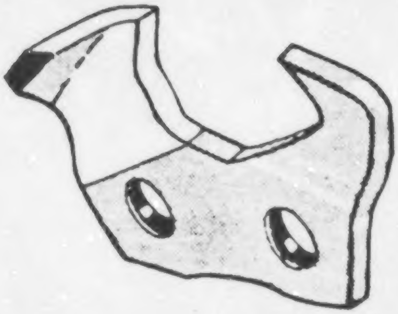
Chisel


Square Corner
at Top and
Side Plate
Intersection



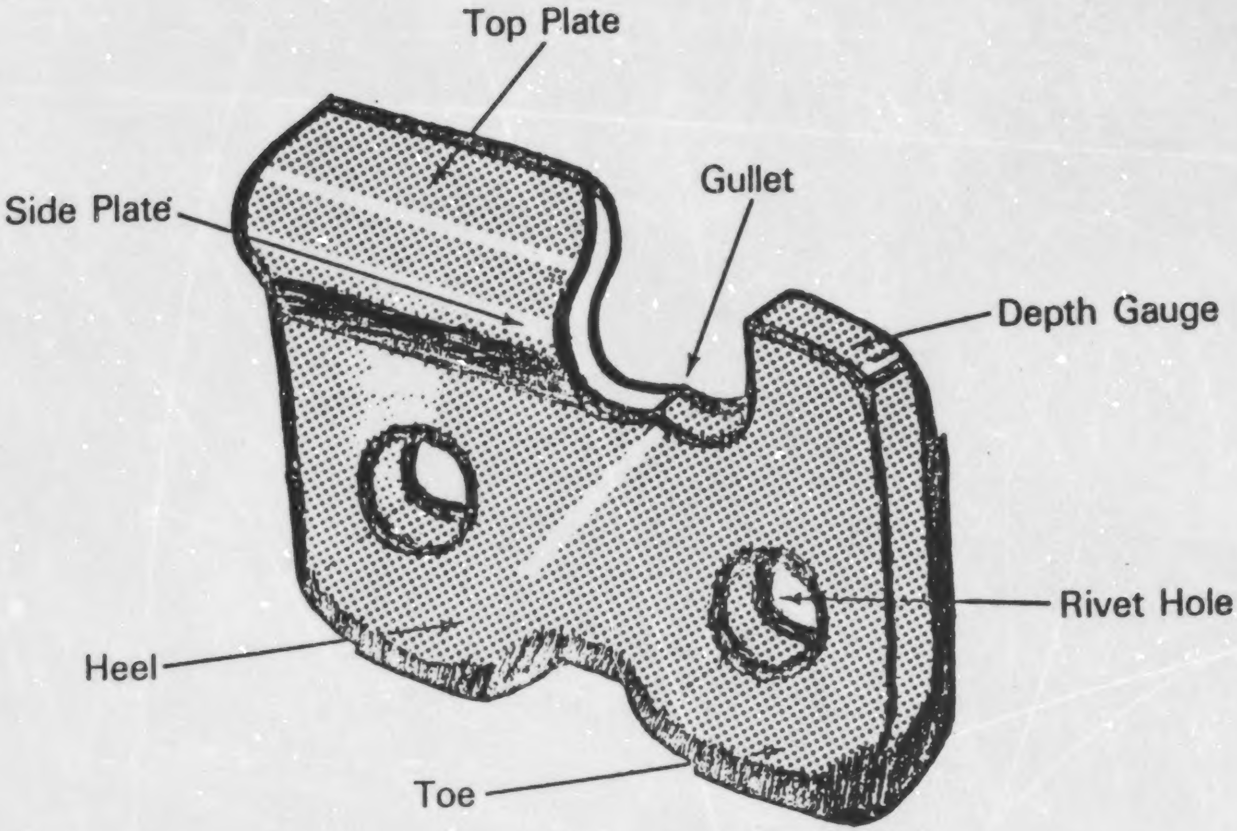
Semi and
Micro Chisel


Round Corner
at Top and
Side Plate
Intersection
Flat Side Plate

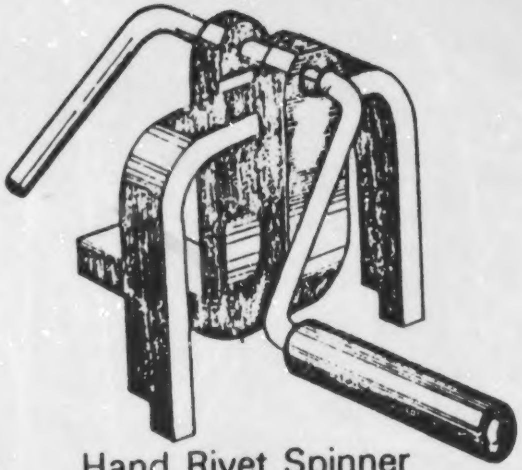


Power Sharp

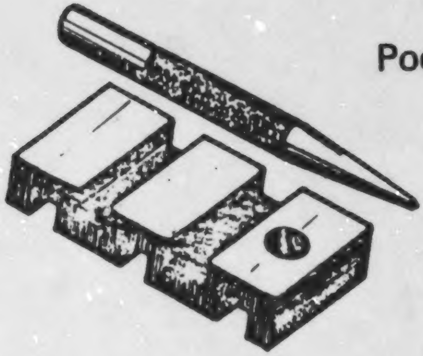
Main Parts of A Cutter


Top Plate
Side Plate
Gullet
Depth Gauge
Rivet Hole
Heel
Toe

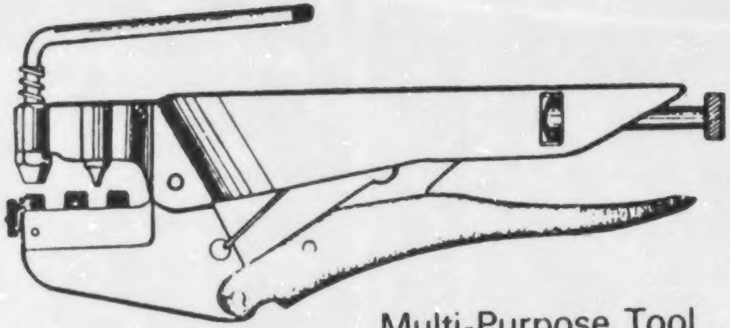
Tools Used To Replace A Chain Link



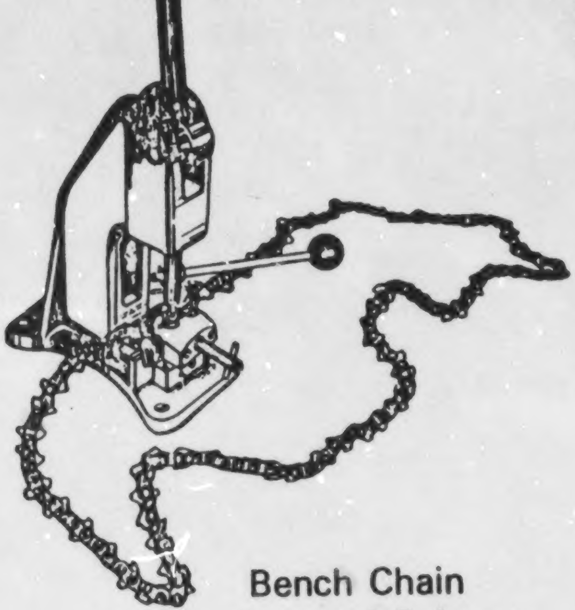
Hand Rivet Spinner



Pocket Chain Breaker



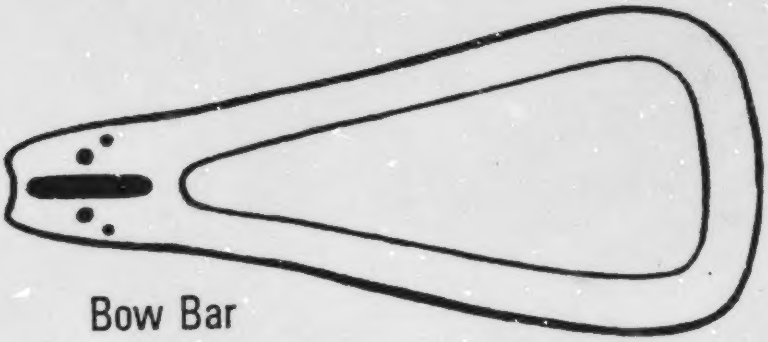
Multi-Purpose Tool



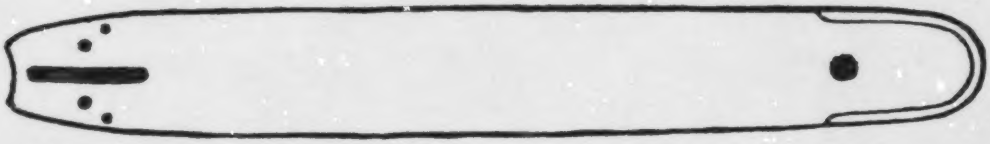
Bench Chain Breaker and Spinner

Appendix E

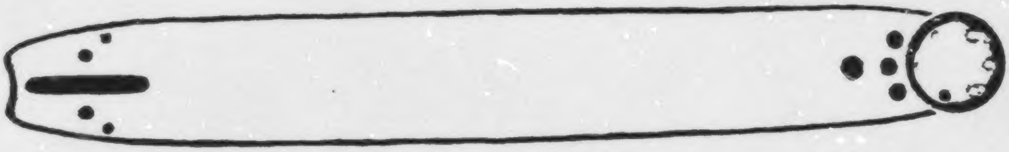
Types of Bars



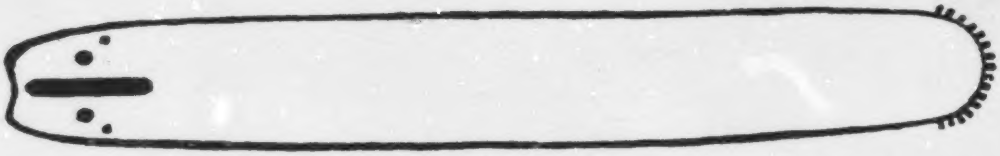
Bow Bar



Solid Nose Bar

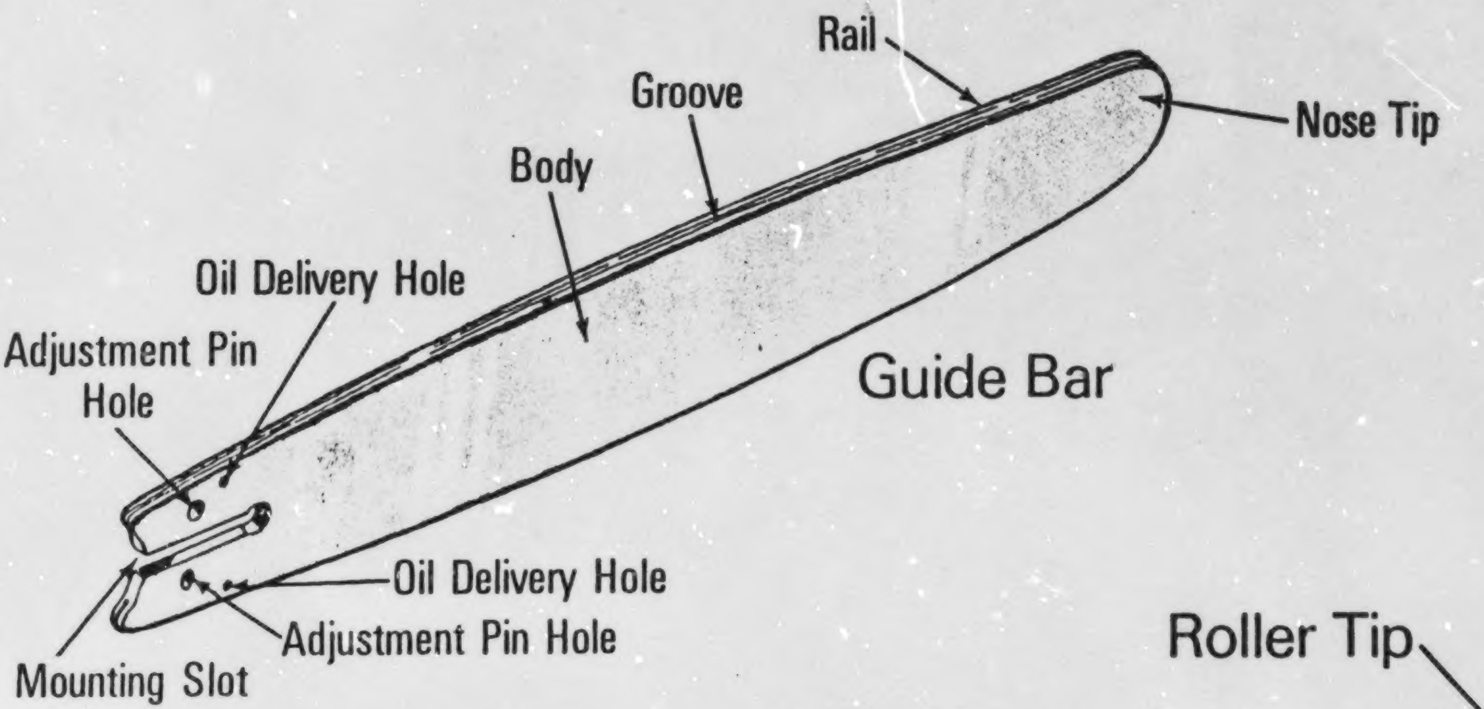


External Roller
Nose Bar

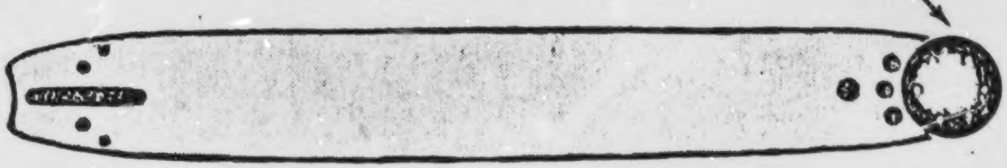


Internal Roller
Nose Bar

Main Parts of a Bar

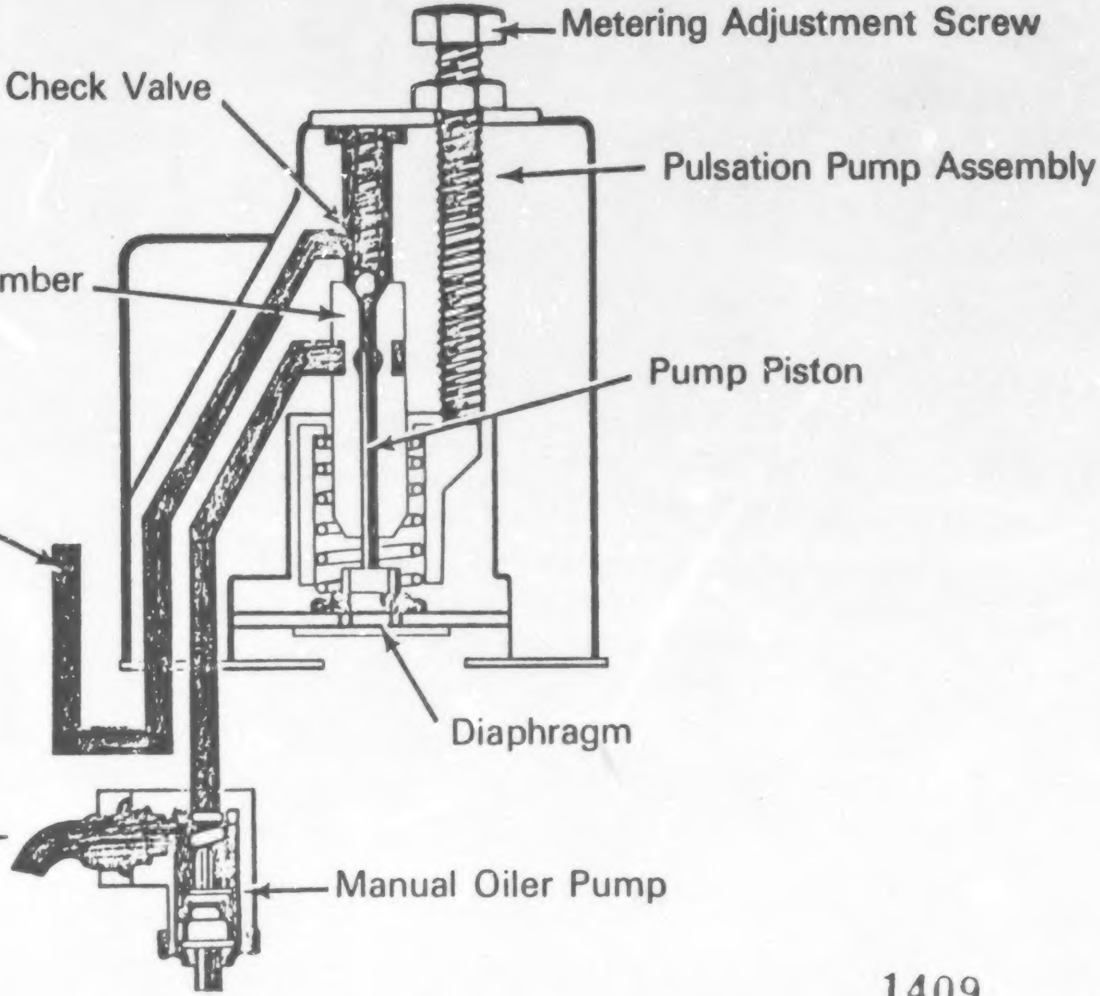

Rail
Groove
Nose Tip
Body
Oil Delivery Hole
Adjustment Pin Hole
Guide Bar
Oil Delivery Hole
Adjustment Pin Hole
Mounting Slot

1406

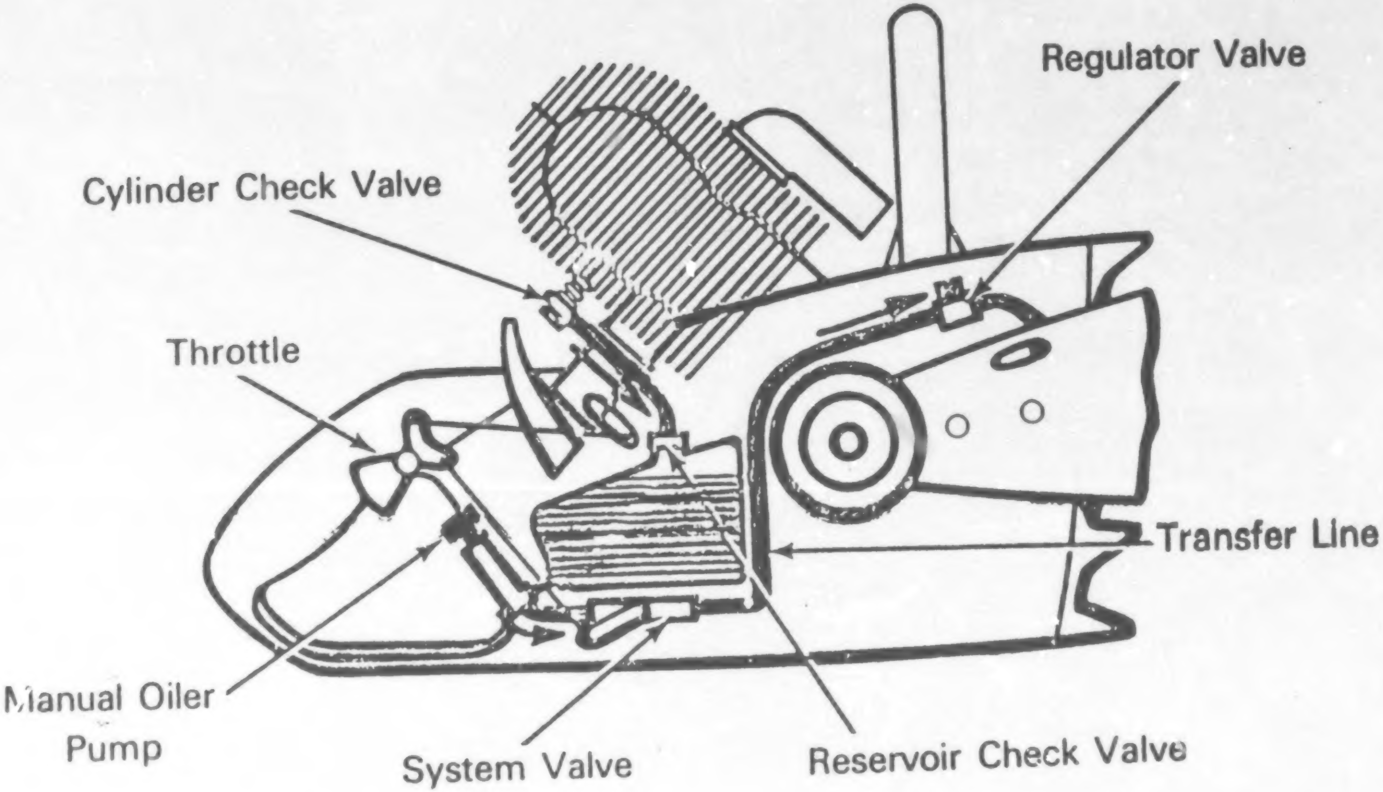


1407

Pulsation Pump


Metering Adjustment Screw
Check Valve
Pulsation Pump Assembly
Metering Chamber
Pump Piston
Transfer Line
to Bar Outlet
Diaphragm
Inlet Supply Line
from Oil Reservoir
Manual Oiler Pump

Cylinder Check Valve Pump

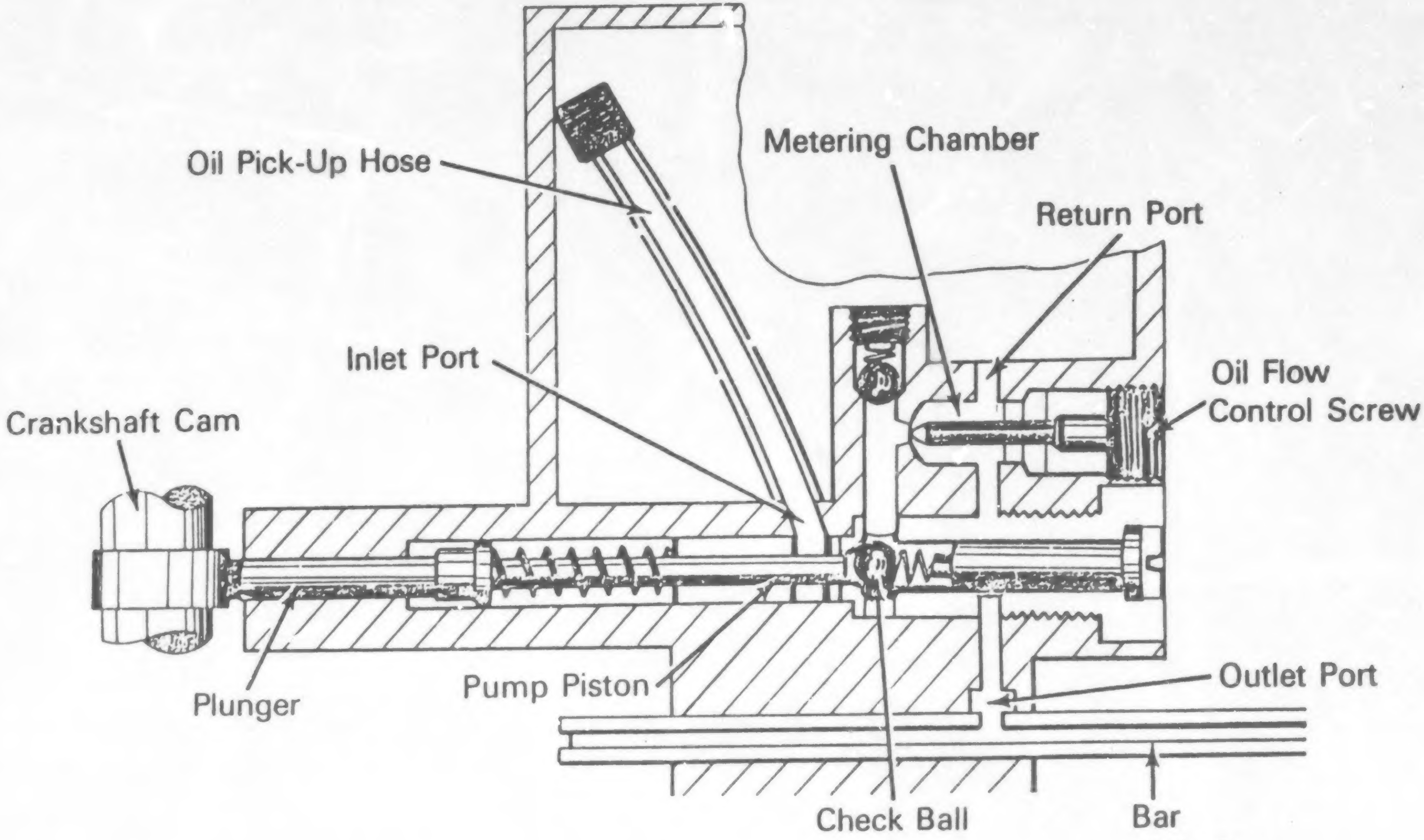


Regulator Valve
Cylinder Check Valve
Throttle
Transfer Line
Manual Oiler Pump
System Valve
Reservoir Check Valve

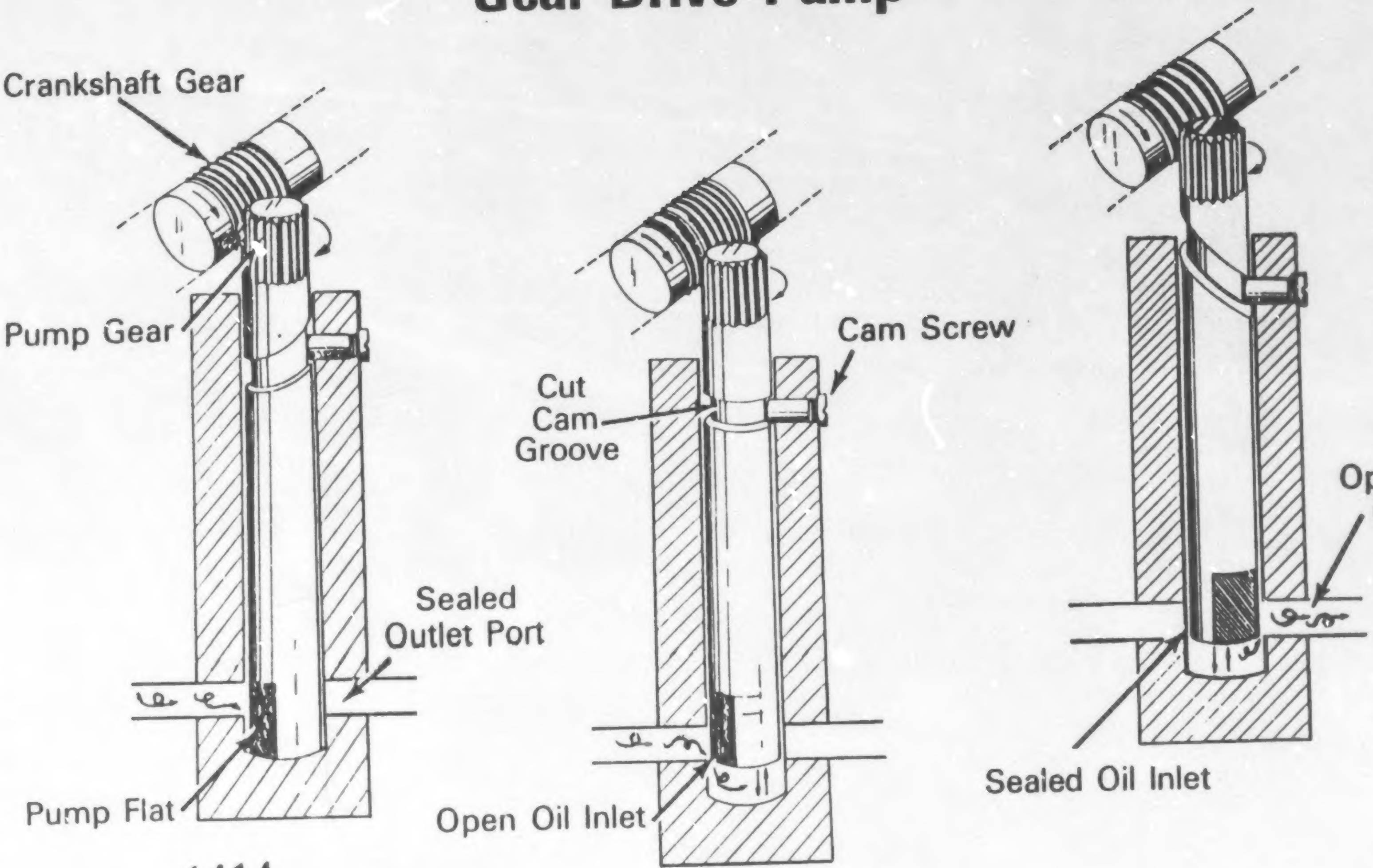
Appendix H

AgIII-XX-19

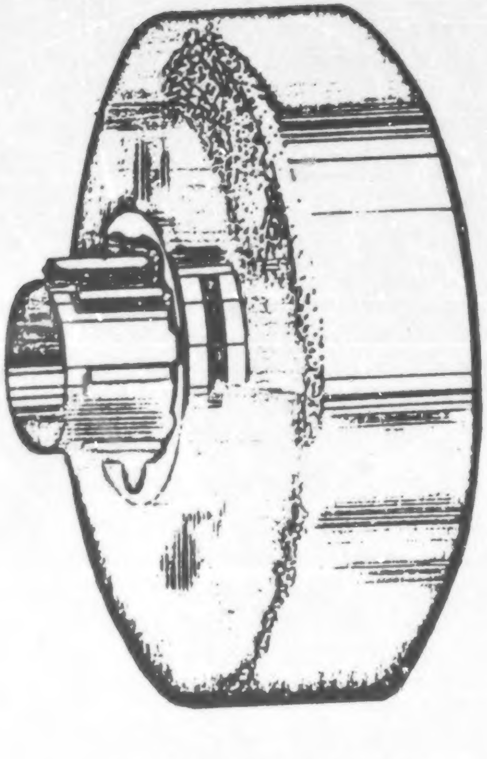
Cam Operated Pump


Oil Pick-Up Hose
Metering Chamber
Return Port
Inlet Port
Oil Flow Control Screw
Crankshaft Cam
Plunger
Pump Piston
Outlet Port
Check Ball
Bar

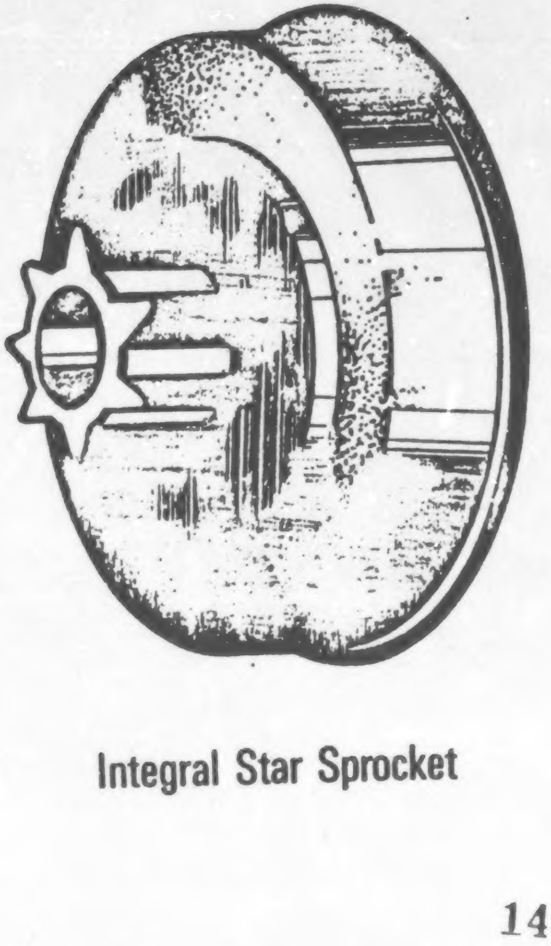
Gear Drive Pump


Crankshaft Gear
Pump Gear
Sealed Outlet Port
Pump Flat
Cut Cam Groove
Cam Screw
Open Oil Inlet
Open Oil Outlet
Sealed Oil Inlet

Types of Sprockets

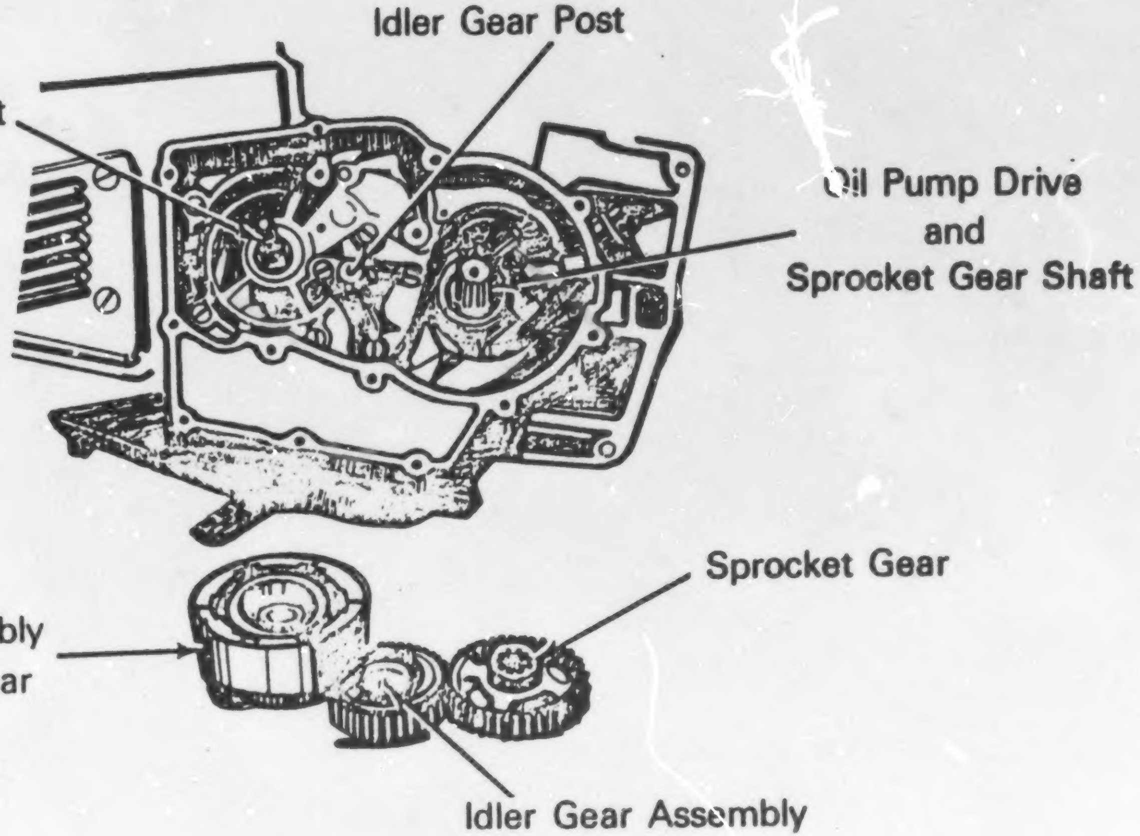


Self Aligning Sprocket

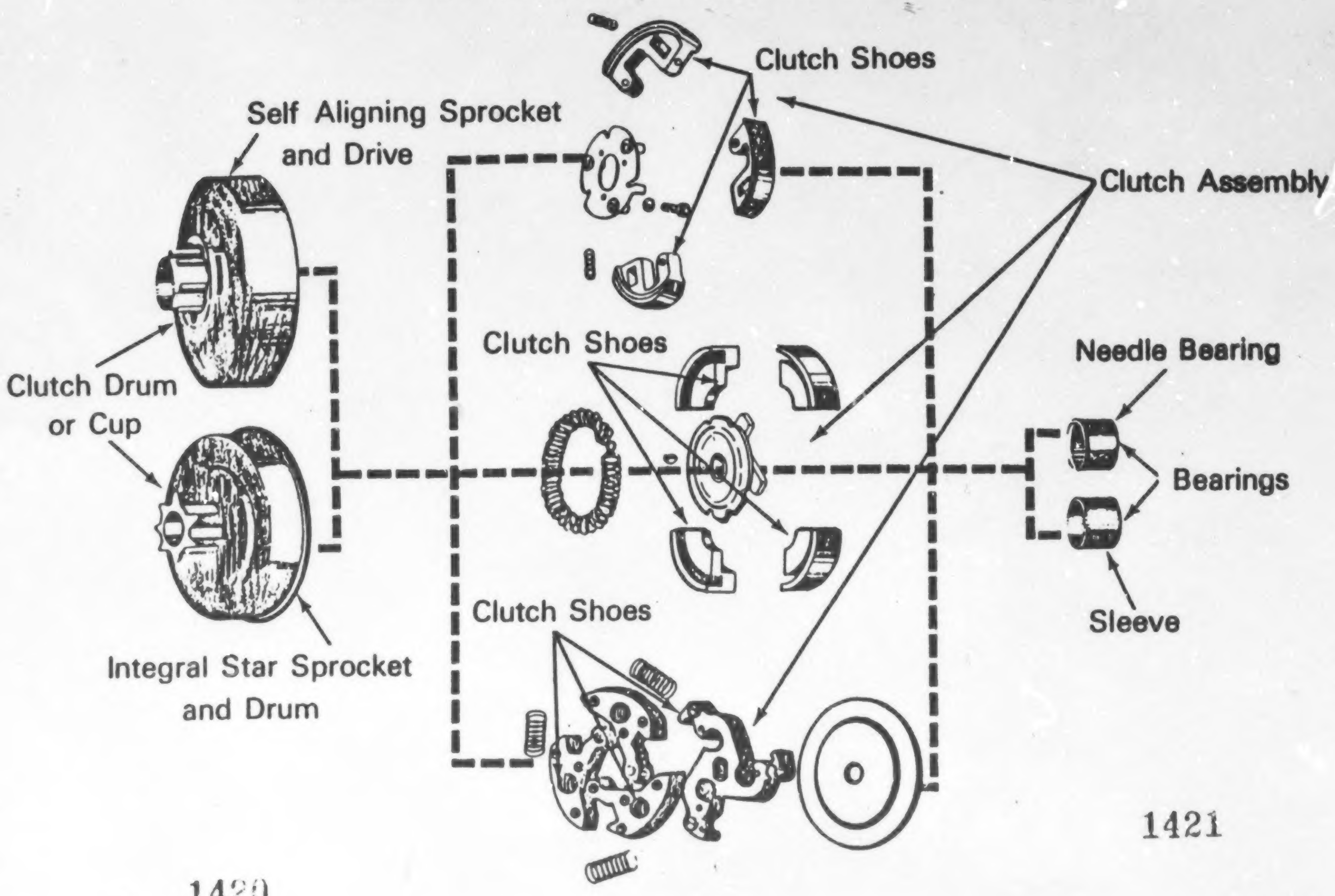


Integral Star Sprocket

Parts of A Gear Reduction Assembly


Idler Gear Post
Crankshaft
Oil Pump Drive
and
Sprocket Gear Shaft
Sprocket Gear
Clutch Assembly
With Drive Gear
Idler Gear Assembly

Parts of A Direct Drive Assembly


Clutch Shoes
Self Aligning Sprocket and Drive
Clutch Assembly
Clutch Shoes
Needle Bearing
Clutch Drum or Cup
Bearings
Sleeve
Clutch Shoes
Integral Star Sprocket and Drum